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## WATER POWER DEVELOPMENT ON THE CHICAGO DRAINAGE CANAL.

The utilization of the water power developed by the flow of the Chicago drainage canal has been suggested and investigated at various times, but the first definite steps were taken in July, 1903, when the Trustees of the Sanitary District decided to take advantage of a law passed at the previous session of the legislature. This law, as explained in our issue of Sept. 10, 1903, provided for the development of water power at Lockport, and enabled the Trustees of the Sanitary District to provide for the payment of the cost of this development by levying and collecting annually, for three years, a tax not exceeding 0.25% of the value of the taxable property within the corporate limits of the district. Plans were prepared by Mr. Isham Randolph, M. Am. Soc. C. E., Chief Engineer of the Sanitary District, to whom we are indebted for information and drawings used in the preparation of the present article.

The general scheme is clearly shown by the plan, Fig. 1. The present drainage canal is 28 miles long, commencing at the Chicago River at Robey St. (Chicago), and terminating at Lockport, Ill., in a large basin. At one side of this basin are the bear-trap dam and Stoney sluice gates discharging the flow of water into the tail race leading to the Desplaines River. The construction of this tail race was described in our issue of July 6, 1899. The new water power channel forms an extension of the main canal, and is 160 ft. wide on the bottom, this being the same as the width of the canal in rock excavation. It has also a grade of 1 in 20,000, in continuation of the grade of the bottom of the present canal. The first section of the channel, or the head race, is about 10,600 ft. in length, and terminates in a wide basin forming the head bay of the power house. The second section of the channel, or the tail race, is about 11,500 ft. in length, of which 5,000 ft. consists of a new channel for the Desplaines River. This section extends from the power house to the "upper basin" at Joliet, about 2,000 ft. above the State dam. It will be noticed that a line of crib work extends down the middle of the new river channel, and the purpose of this is to act as a cofferdam to enable the contractor to excavate the rock in the east half of the channel. The law requires that the channel shall have a depth of at least 10 ft. Fig. 2 is a profile of the water power extension.

The head race channel, from the present canal to the power house, will be formed by two embankments, as shown in the cross section, Fig. 3. On the east side will be a rock-fill embankment faced with a concrete retaining wall. This wall, shown in detail in Fig. 4, will be about 37 ft. high, 15 ft. wide at the base, and 6 ft. wide for a depth of 12 ft. from the top. The increase in width is effected by benches 9 ins. wide and 24 ins. high. On the west side of the channel will be an embankment or levee having an earth core 5 ft. wide on top and side slopes of 1½ to 1; on each side of this will be a rock fill 22½ ft. in width at the top, with slopes of 1 to 1. This makes a total top width of 50 ft. Where the earth bank is high, it has a masonry core wall, and the water side is faced with rip-rap, while the rock fill proper is on the land side. Fig. 5 shows the construction of the crib bulkhead, and Fig. 6 shows cross sections of the Desplaines River valley at the Lockport road and the Wire-Mills road.

BEGINNING ROCK EXCAVATION WITH RAND DRILLS ON WATER POWER CHANNEL OF THE CHICAGO DRAINAGE CANAL.

The basin at the power house will be connected with the channel below the tail race by a lock 130 × 22 ft., so that when this water-power extension is completed, the Chicago and Joliet section of the old Illinois & Michigan Canal (shown on the plan, Fig. 1) can be abandoned, the drainage and water power canal being available for barge navigation. As shown by the plan, this section of the old canal enters the "upper basin," just above the mouth of the new canal; the next section of the old canal commences at the lock at the west end of the State dam at Joliet. Provision will also be made for a large lock at the power house in the future, when the Chicago drainage canal comes to be utilized as a ship canal, as is intended. The head bay will have (in addition to the lock) an outfall fitted with a bear-trap dam for regulating the flow and for carrying off ice and floating debris.

The power house will be 142 × 390 ft., of concrete and brick construction, and will contain eight large units (each consisting of three pairs of 54-in. wheels) and three small exciter units (each consisting of one pair of 30-in. wheels). All the units will have horizontal shafts. The larger units will develop 6,500 HP. each and the smaller units 600 HP. each, with gate full open and with the full head of 34 ft. The present flow is 4,500 cu. ft. per second, while the ultimate flow will be 13,000 cu. ft. per second. The present contract is for four power units of the Jolly-McCormick type, 6,500 HP. each, and two exciter units. Each power unit is to consist of six 54-in. runners keyed to one horizontal shaft of nickel steel, the normal speed being 165 revolutions per minute, and the shaft being coupled directly to a generator outside the bulkhead. Each of the exciter units will consist of two 30-in. turbines discharging through a single draft tube, and running at 300 revolutions per minute. The power and exciter units will all be controlled by Lombard governors. The turbines are guaranteed to have an efficiency of not less than 80%, and are to be tested for efficiency at the testing plant at Holyoke, Mass. A special feature is that all the journals of the turbine shafts will be lubricated by oil, instead of depending upon water lubrication. An oil circulating system will be used, and will be so arranged as to show at a glance whether each bearing is getting its proper amount of oil. The draft tubes and waste weir will be of concrete construction, as will also be the turbine chambers and bulkheads.

The contractors for the water-power canal extension are Joseph J. Duffy and the Lorimer & Gallagher Co., both of Chicago. The former has sections Nos. 1, 2 and 3, earth and rock work; the latter has section No. 4, rock and crib work. The estimated cost of the entire work, including power house and machinery for 18,000 HP., with a flow of 300,000 cu. ft. per minute, was $2,537,000, and the four construction contracts aggregated $1,-

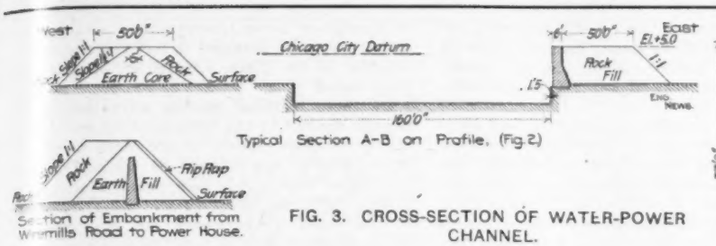


FIG. 3. CROSS-SECTION OF WATER-POWER CHANNEL.

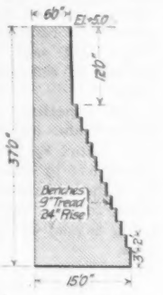


Fig. 4. Concrete Retaining Wall for Water-Power Channel.

the latter is distinct from the preliminary process. It may be said that the treatment with zinc chlorid does not seem to further reduce the strength of timber beyond the effect of the steaming process. This might have been expected when it is considered that the strength of the zinc chlorid solution ordinarily used does not exceed 2½%. The strength of timber that had been treated with the 2½% solution of zinc chlorid after having been steamed four hours at 20 lbs. pressure was the same as that of timber which had been steamed without the subsequent application of zinc chlorid. The same statement may be made of timber treated with an 8½% solution of zinc chlorid. It may be that subsequently the crystallization of the zinc chlorid will weaken the wood fiber. This remains to be determined.

The effect of the creosote appears to be the same as that of an equal amount of water in weakening the fiber. That is to say, the strength of creosoted timber is that of green timber. The difference is that while green timber gains strength upon seasoning, the creosote oil remains in the wood, and, it appears from analysis of a pile 35 years old, that the oil remains in a liquid condition. Consequently, comparison between seasoned timber and creosoted timber will always result to the disadvantage of the latter as far as its strength is concerned. In the case of creosoted wood, it also remains to determine what changes in the wood fiber take place through lapse of time in the presence of creosote oil.

It is expected that a bulletin will be issued upon the results of these investigations when the tests are completed. This bulletin will also contain the results of the investigations to determine the best methods of preserving wood so that the maximum impregnation may be obtained with the least expenditure of oil per cubic foot of timber.

## THE FUNCTIONS OF VARIOUS TYPES OF BACTERIA IN THE PURIFICATION OF SEWAGE, WITH SOME METHODS FOR THEIR QUANTITATIVE DETERMINATION.

By H. W. Clark* and Stephen De M. Gage.†

In the purification of sewage by bacterial methods a large number of complex reactions take place in the sewage, nearly all of which are caused by the action of bacteria. The reactions occurring may be divided into three general groups as follows:

I. PUTREFACTION. a—*Hydrolysis* (Peptonization or Bacteriolysis) of solid matters, albumens, etc., forming albumoses, peptons, amido compounds and salts of organic acids.

b—*Fermentation of Urea*, forming ammonia and carbonic acid gas.

c—*Fermentation of Amido Bodies*, albumoses and peptons forming ammonia and setting nitrogen free.

d—*Fermentation of Salts of Organic Acids.*

e—*Fermentation of Cellulose.*

f—*Fermentation of other Carbohydrates.*

g—*Fermentation of Fats.*

h—*Fermentation of Sulphur Compounds*, forming hydrogen sulphide or Mercaptans.

II. NITRIFICATION AND OXIDATION. Conversion of $NH_3$ to nitrites and nitrates, oxidation of carbonaceous products to carbonates or $CO_2$ with liberation of H, $CH_4$ and $H_2O$ and oxidation of sulphur compounds.

III. DENITRIFICATION. Reduction of the nitrates and nitrites formed to ammonia and nitrogen with the liberation of O, which may be used again by the nitrifying bacteria in the formation of nitrites and nitrates, or may be used in the oxidation of the carbonaceous matter. Many of the bacteria of putrefection have the power to reduce nitrates and nitrites, and these are assisted by other types which have this power but which play no part in any of the processes enumerated under I.

In the filtration of sewage three main types of filters are in use at the present time, namely, intermittent sand filters, contact filters and intermittent continuous or sprinkling filters.* In the operation of these filters different methods are followed and varying results obtained. Preliminary treatment in settling and septic tanks is more or less generally practiced.

The measure of the actual purification of sewage produced by a filter is obtained largely by means of chemical analyses, although determinations of the number of bacteria present in a filter effluent are of more or less value. It is, of course, unnecessary to discuss here the measure of good or poor purification results as shown by chemical analyses, as they are so well known. The aim in filtration has been to have the nitrification or oxidation stage as complete as possible, and it is well known that the cause of good or poor nitrification in a filter is largely one of sufficient or insufficient oxygen in the filter to encourage favorable or unfavorable bacterial action. Hitherto, while we have known that various reactions go on in the filters and have been able to measure by means of chemical analysis the end products of these reactions and to determine the amount of change which has taken place in the filters, we have been unable through lack of proper methods to isolate the various groups of bacteria performing these chemical changes, and to measure their activity. In other words, the ordinary bacterial determinations of numbers only do not yield information concerning the part which bacteria of different types play in the process of purification, and the present studies have been devoted to finding methods by which the functions of the different groups of bacteria may be determined and to the expression of these functions quantitatively.

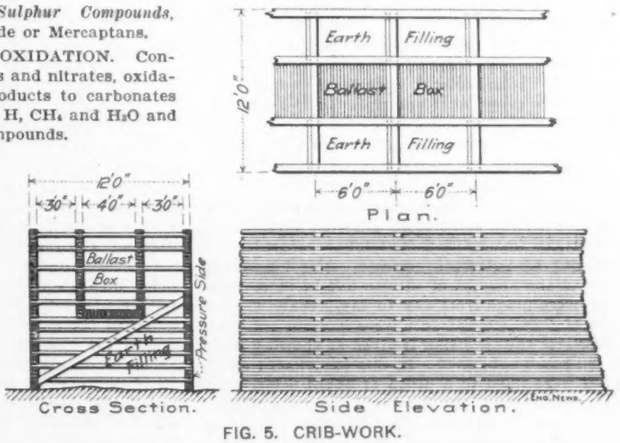


FIG. 5. CRIB-WORK.

The cultivation and study of the nitrifying bacteria is a matter of great difficulty and has not been attempted in this work. The isolation of the various putrefactive and denitrifying bacteria is, however, much more easy. In the present study attempts have been made to isolate from sand taken from filters in use, from sewage and from the effluents of sewage filters types of bacteria capable of producing certain results, and by determinations of the number of bacteria of these types present in the samples tested to work out the main action taking place, or which may take place, in the sample or filter under examination. That is, we have attempted to work out bacterial or biochemical tests which will give us a bacterial measure of the changes which may occur in filters and in filter effluents.

The studies were begun largely as part of an investigation to explain the somewhat poor purification results which had been obtained from some of the large out-of-door filters at the Lawrence Experiment Station during recent winters, and of the difference in the degree of purification accomplished by some of our experimental contact filters. The studies have included the operation of certain small experimental filters which were put into operation as a preliminary study, as explained on pages 236 to 240, inclusive, of the

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†Biologist of Lawrence Experiment Station, Lawrence, Mass.

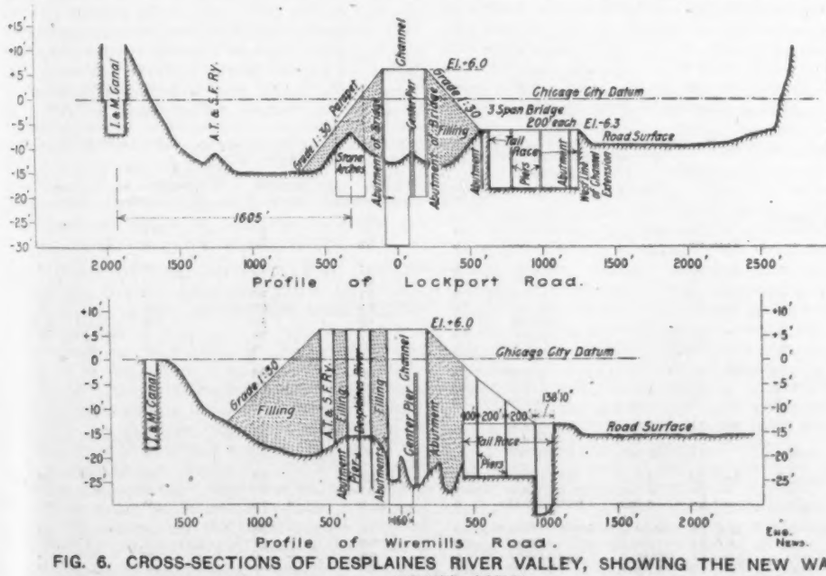


FIG. 6. CROSS-SECTIONS OF DESPLAINES RIVER VALLEY, SHOWING THE NEW WATER-POWER CANAL.

(*For this third class of filters we prefer the name percolating. "Intermittent continuous" is awkward and lacks in comprehensiveness, since it excludes the continuous filters which naturally fall in class three.—Ed.)

898,468. This leaves $640,532 for the power house and machinery, which amount Mr. Randolph considered sufficient for the purpose. The contract above mentioned for the first part of the turbine equipment has been awarded to the Wellman-Seaver-Morgan Co., of Cleveland, O. Under the contracts, the head and tail race channels are to be completed by October, 1905, and the turbines are to be installed by January, 1906. The contracts for the power house and the electrical equipment have not yet been awarded.

The construction of the canal extension is largely in rock excavation and on the three sections comprised in Mr. Duffy's contract the drills, channeling machines and pumps are operated by

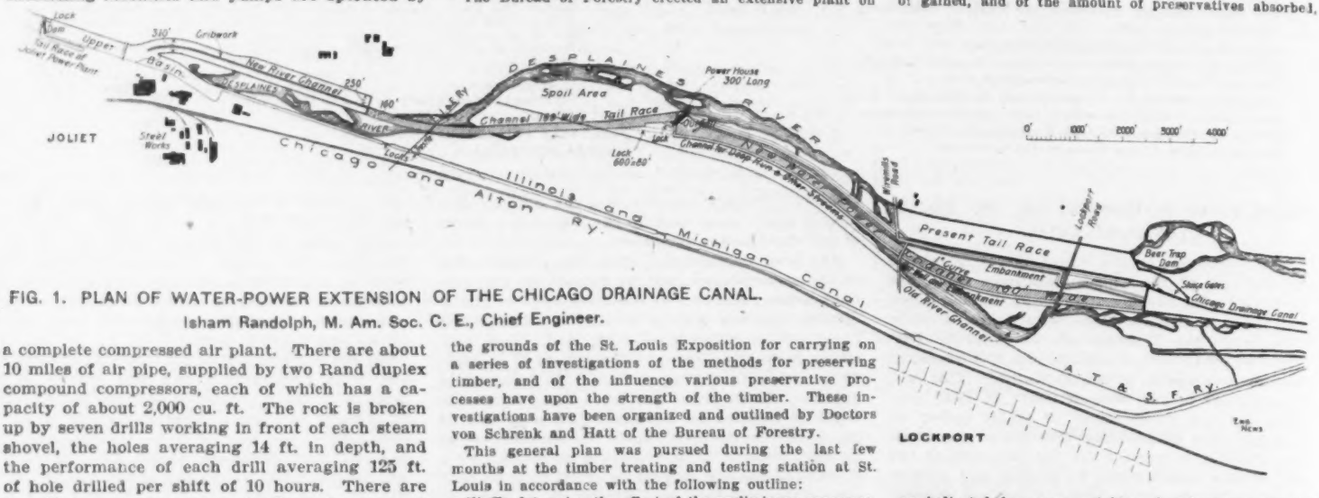


FIG. 1. PLAN OF WATER-POWER EXTENSION OF THE CHICAGO DRAINAGE CANAL.
Isham Randolph, M. Am. Soc. C. E., Chief Engineer.

a complete compressed air plant. There are about 10 miles of air pipe, supplied by two Rand duplex compound compressors, each of which has a capacity of about 2,000 cu. ft. The rock is broken up by seven drills working in front of each steam shovel, the holes averaging 14 ft. in depth, and the performance of each drill averaging 125 ft. of hole drilled per shift of 10 hours. There are four 70-ton steam shovels with 3-yd. dippers, and the construction plant also includes the following: 32 Rand "Little Giant" drills, 4 track channelers, 2 stone crushers with a capacity of 8,000 yds. per day, 2 portable concrete mixers, 14 locomotives of 14 tons weight, 150 dump cars, 15 miles of track, 2 hoisting engines, 15 suction pumps, 2 centrifugal pumps, four boilers of 40 to 110 HP., an electric light plant, and a machine and blacksmith shop. There is a camp consisting of about 11 buildings and about 500 men are employed on the work.

## THE STRENGTH OF TIMBER TREATED WITH PRESERVATIVES.*

With the increasing use of timber, preserved in one way or another against decay and fire, it is important to determine the effect which the preserving process has upon the strength of the preserved timber. Many engineers believe that creosoted timber is more brittle and less capable of withstanding strains than the same timber before being treated with creosote. This is particularly true with bridge timbers and piling.

Actual tests are necessary to determine what relationship exists between the preservative process and the strength of the timber. Most of the tests hitherto madd with preserved timber were made by comparing results of tests on treated sticks with results on untreated sticks. In many instances these turned out in favor of the untreated timber. The reason why such tests are unfair to the preservative is that in the process of preservation two factors enter: (1) The actual process of impregnation with a preserving substance, and (2) The preliminary process of steam seasoning, in the majority of treating plants in the United States. A piece of timber subsequently treated with creosote may be steamed to such an extent that the timber becomes exceedingly brittle. This, obviously, will be the fault of the steaming and not of the creosote.

Timber preservation divides itself broadly into three stages: First, the preliminary preparation; second, the actual preservative process; and, third, the treatment of timber following preservation. The final strength of the timber may be influenced materially by each of the stages.

The Bureau of Forestry erected an extensive plant on the grounds of the St. Louis Exposition for carrying on a series of investigations of the methods for preserving timber, and of the influence various preservative processes have upon the strength of the timber. These investigations have been organized and outlined by Doctors von Schrenk and Hatt of the Bureau of Forestry.

This general plan was pursued during the last few months at the timber treating and testing station at St. Louis in accordance with the following outline:

(1) To determine the effect of the preliminary processes, such as steaming, on the mechanical properties of the timber.

(2) To determine the effect of preservatives on the strength of timber, eliminating the effect of the preliminary processes.

In order to determine the effect of these factors, the programme was divided into two parts—part 1, the effect of the preliminary process, and part 2, the effect of preservatives.

The effects of the preliminary process were determined only on loblolly pine. Both green and seasoned timber was used in determining the effect of preservatives. The preservative fluids investigated included only creosote and zinc chlorid.

In making comparative strength tests of treated and untreated timbers, it is necessary to eliminate as far as possible the variations due to the great differences in quality of individual pieces of wood. This was accomplished in this case by using 11-ft. timbers cut at the same time from one forest site. In testing the influence of preliminary processes of seasoning, a 3-ft. section was cut from one end of each timber and sawed up into test pieces, which furnished a basis of comparison between (1) the results of tests on these "control" pieces, and (2) the results on test pieces taken from the remaining 8-ft. section after the latter had been subjected to the various preliminary seasoning processes in the treating cylinder.

In testing the effect of preservatives themselves, the entire 11-ft. timber was subjected to the preliminary seasoning processes, after which a 3-ft. section was cut from the end of each timber. The 3-ft. section thus having been subjected to the preliminary seasoning processes formed a basis of comparison with the remaining 8-ft. section, which was treated with the preservatives. In this way the separate effects of the preliminary processes and the effects of the preservatives could be isolated and determined.

Because of an apprehension that defects of brittleness of treated timbers might not be evidenced by the ordinary tests under slowly applied loads, provision was made for both static tests and impact tests. The test pieces were subjected to cross-bending strain, compression along the grain under both static and impact conditions, and upon shearing parallel to the grain and compression at right angles to the grain under static conditions. The data taken include the moisture conditions, specific gravity, and rate of growth. During the treating operations, records were kept of the temperature to which the timbers were subjected at all stages, the amount of water lost or gained, and of the amount of preservatives absorbed, as indicated by gross weight and subsequent chemical analyses of the test pieces.

Ordinarily the strength tests were made immediately after treatment in the cylinder. In order, however, to determine what weakness might be introduced by changes in the physical condition of the preservatives in the wood through the lapse of time, a complete series has been set aside for subsequent operations. An additional set of test pieces has been loaded with different percentages of the strength, as exhibited under the ordinary tests, and this load allowed to act for long periods of time, the deflections being measured from day to day.

While this programme is not sufficiently advanced to allow the drawing of final conclusions, yet the preliminary results are fairly indicative of what may be expected. It is found that the steaming process weakens the resistance of the wood fiber to both static and impact loadings. It may be stated that this diminution of strength is very nearly in direct proportion to the length of time that any given steam pressure is applied. The diminution of strength was found to be 25% after a pressure of 20 lbs. was applied for ten hours to green loblolly pine, and 10% when a pressure of 20 lbs. was applied for four hours. This diminution of strength increased very rapidly when the pressure rose above 20 lbs., and amounted to about 25% when a pressure of 50 lbs. was applied for four hours.

It will be easily seen that when the conditions of time and pressure are made very severe, the conditions prevailing in a pulp mill industry will be approximated. Evidently it is well to avoid when possible the use of these preliminary steaming operations in the wood preserving industry.

With relation to the effect of preservatives themselves,

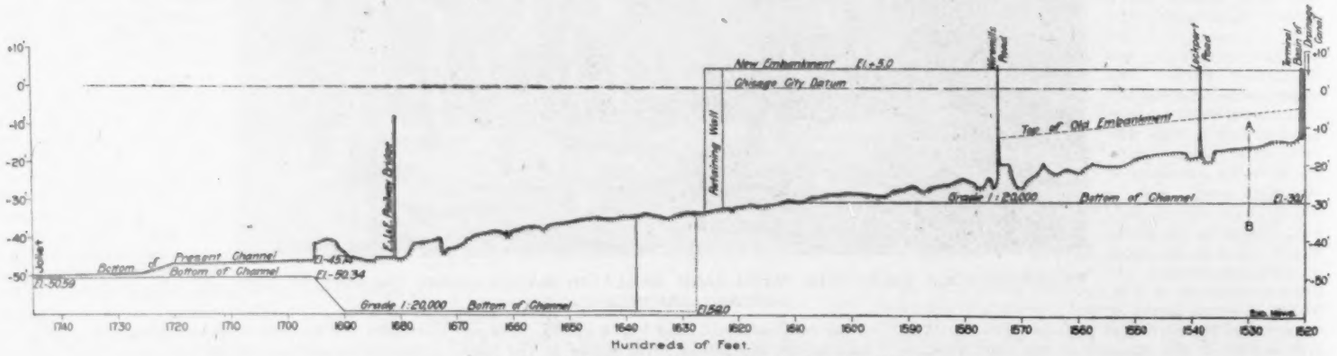


FIG. 2. PROFILE OF WATER-POWER EXTENSION.

*A statement of the results of tests carried out at the St. Louis Exposition by the Bureau of Forestry, U. S. Department of Agriculture.

Report of the Massachusetts State Board of Health for 1903.

Following this, various samples of sand were taken from filters, some of which were producing good purification and others poor purification, for a study of the tendency of the majority of the bacteria in these sands to cause nitrifying or denitrifying action. Tests were made of the effluents of the small experimental filters previously mentioned, and of sand from certain sand filters, some of which were producing good, and others poor purification, to determine the approximate number of bacteria of different types in these effluents and the reaction of these types of bacteria on nitrates in solution.

Following this preliminary study, methods were devised for the determination of the total power of the bacteria in sewage or an effluent to produce ammonia from organic matter, this function being called the "ammonifying coefficient"; of the power of these bacteria to liquefy albuminous matter, this function being called the "liquefying coefficient"; of the power of these bacteria to reduce nitrates, this function being called the "denitrifying coefficient"; and of their power to liberate nitrogen from nitrates, this function being called the "nitrogen-liberating coefficient."*

In determining these coefficients it has been assumed that the change which may take place in a liquid, such as sewage or the effluent from a sewage filter, by the action of bacteria is dependent not only on the total number of bacteria in that liquid, but on the capacity of certain predominant groups of these bacteria to perform certain work even in the presence of other groups of a different power.

## STUDIES OF THE TENDENCY OF THE SAND FROM FILTERS TO INDUCE DENITRIFICATION.

In studying this point, many experiments were made in which sands from different filters were placed in solutions containing considerable amounts of potassium nitrate, and determinations of the amount of nitrate left in these solutions were made from day to day. While the results of these experiments were more or less contradictory, the following is given as showing some of the results obtained. In this experiment small tubes were filled to a depth of about 6 ins. with sand from Filters Nos. 1, 9A and 213, respectively. Filters Nos. 1 and 9A at this time—that is, during cold winter weather—had only small amounts of nitrates in their effluents, while the effluents of Filter No. 213 contained a large amount of nitrate; 200 cu. cm. of nitrate solution, containing about 9.1 parts of nitrates per 100,000, were then put into each tube containing sand, and the outlets opened for a short time in order that the solution might pass into the sand and air might be removed from the sand, the nitrate solution passing through being returned to the tube. These tubes containing the sand and the nitrate in solution were then kept in the laboratory for a number of days. At the same time, control tubes of like sand were used, into which water, free from ammonia and practically free from nitrates, was placed. The solutions were examined daily and the results are given in Table I. This table shows that in four days the nitrates in the solution introduced into the tubes containing sand from Filters Nos. 1 and 9A were reduced from 9.1 parts to .92 and .22 parts per 100,000, respectively, while the nitrate solution in the tube containing sand from Filter No. 213 was but slightly reduced, and at the end of four days contained 7.90 parts per 100,000. At the same time, the nitrites in the liquid in the tubes containing sand from Filters Nos. 1 and 9A increased from practically zero to 1.6 and .22 parts per 100,000, while the nitrite in the solution in the tube containing sand from Filter No. 213, at the end of four days, was only .0020 parts per 100,000. The free ammonia in the solution in the tubes containing sand from Filters Nos. 1 and 9A, increased very rapidly, while that in the tube containing sand from Filter No. 213 increased but slowly and remained practically constant after 24 hours. It was evident, also, that a certain amount of nitrogen was liberated from the solutions.

This experiment tended to show that poor purification and nitrification at this time in Filters Nos. 1 and 9A was not caused by cold weather alone, but by groups of bacteria tending to prevent the formation of nitrates or reducing them when formed, the predominance of these groups being caused by low temperature and other reasons.

TABLE I. Showing Relative Tendency of Sand from Filters Giving Good and Poor Nitrification to Induce Denitrification.

(Parts per 100,000.)

| Days from start. | Sand flooded with nitrate solution. Filter 1. | Filter 9. | Filter 213. | Sand flooded with distilled water. Filter 1. | Filter 9. | Filter 213. |
|---|---|---|---|---|---|---|
| | | | Nitrates. | | | |
| 0 | 9.08 | 9.08 | 9.08 | ..... | ..... | ..... |
| 1 | 2.93 | 1.51 | 7.56 | .15 | .24 | .42 |
| 2 | 5.18 | 1.78 | 8.40 | .08 | .12 | .17 |
| 3 | 3.37 | 0.75 | 9.24 | .18 | .29 | .17 |
| 4 | 0.92 | 0.22 | 7.90 | .22 | .17 | .17 |
| | | | Nitrites. | | | |
| 1 | 1.1000 | 0.2500 | 0.0020 | .0000 | .0100 | .0000 |
| 2 | 0.7000 | 0.3200 | 0.0000 | .0000 | .0020 | .0000 |
| 3 | 1.2500 | 0.3000 | 0.0020 | .0000 | .0000 | .0000 |
| 4 | 1.6000 | 0.2200 | 0.0020 | .0000 | .0020 | .0000 |
| | | | Ammonia. | | | |
| 1 | 3.94 | 3.94 | 1.15 | 2.13 | 1.15 | .64 |
| 2 | 4.10 | 3.77 | 1.15 | 2.87 | 1.31 | .74 |
| 3 | 4.10 | 3.69 | 0.98 | 2.87 | 1.84 | .74 |
| 4 | 5.08 | 3.69 | 1.05 | 2.87 | 1.44 | (2.62) |

## QUALITATIVE STUDIES OF THE POWER OF BACTERIA IN SEWAGES, SEWAGE EFFLUENTS AND SANDS FROM SEWAGE FILTERS TO PRODUCE AMMONIA AND NITRITES IN NITRATE SOLUTIONS.

During the earlier portion of the biochemical studies, qualitative tests only were made for the presence in the samples examined of species of bacteria producing ammonia and nitrites when placed in solutions containing organic matter and nitrates, the procedure being as follows:

Gelatin plates were made from the sample, and after incubation for four days at 20°C. counts were made of the total number of colonies on the plate, of the number which liquefied the gelatin, and of the number of each type of colony which appeared on the plate. Ten colonies representing all of the types of colonies on the plate were then inoculated directly into tubes of nitrate pepton solution and after incubation at 20°C. for seven days qualitative tests were made for the presence of nitrites and ammonia in the solution. By these tests we were able to divide the cultures of bacteria found into four classes: (1) those by which neither nitrites or ammonia were formed, (2) those by which ammonia was formed but no nitrites, (3) those cultures which formed nitrites but no ammonia, and (4) those cultures which formed both nitrites and ammonia. In tabulating the results of these studies, it has been assumed that each culture represented a certain portion of the total number of bacteria in the sample. In the case of certain characteristic colonies it was possible to say that there were so many of each kind. In the case of the non-characteristic colonies the work performed by seven or eight colonies was assumed to be representative of the results which would be obtained if the whole number of colonies on the plate, apparently of this type, were tested.

By these methods, studies were made of the sewage applied to the filters and of the effluents and sand from certain of the large out-of-door filters, which were affected by the extreme cold, and which were giving poor purification, in comparison with the effluents and sand from some of the small filters inside the filter house in which good nitrification was taking place.

The results of these studies are given in Table II., the figures showing the estimated percentage of the total number of bacteria in the sample which liquefied gelatin in four days and the percentage of the total bacteria which would be included in each of the four groups as specified above.

The results disagree somewhat, but in general it appears that the percentage of bacteria in the sand from the out-of-door Filters 1 and 9A capable of reducing nitrates was higher than in the sand from Filters 100 and 213, which were under cover, and the same rule follows, with a few exceptions, in the comparison of the effluents from Filters 1 to 10, inclusive, with the effluents from Filters 226, 227 and 228. That is to say, in this series of experiments we arrived by bacterial methods at the same results and conclusions as by chemical methods in the previous experiments.

## METHOD OF DETERMINING THE AMMONIFYING POWER, DENITRIFYING POWER, AND NITROGEN-LIBERATING POWER.

The results of the qualitative tests, while of interest, showed that these tests were irregular in their results. In the nitrite determinations less nitrite would occasionally be found in the culture than in the blank, indicating that the reduction of the nitrates had gone further than the nitrite stage. Following this, the procedure was modified and the cultures were inoculated into both nitrate pepton solution and into plain pepton solution of the same strength, quantitative determinations being made of the amount of nitrates, nitrites and ammonia formed in the nitrate solution, and of ammonia in the pepton solution. From the first, a period of seven days was chosen arbitrarily as a convenient time for incubation of the cultures.

Much experimental work has been necessary to determine the proper strength of solutions in which to grow the cultures, and to adapt the methods of determination of nitrates, nitrites and ammonia to the class of liquid under examination, both to secure accuracy and rapidity of handling. The methods finally adopted are as follows:

The samples are diluted with sterile water in such amounts that they shall contain from 25 to 100 bacteria per cu. cm., and are plated out on standard gelatin. After incubation for four days at 20°C., counts are made of the total number of colonies on the plate, and of the number of each type of colony. Typical colonies, representing all the apparent types of colonies on the plate, are fished to pepton broth, at least ten such cultures being made, and a sufficient number of each type of colony being fished to form an

TABLE II.—Showing Results of Qualitative Tests for Nitrites and Ammonia on Representative Cultures of Bacteria from Sewages and from the Sand and Effluents from Sewage Filters.

| Sample. | 1903 and 1904. | Depth. | Bacteria per c. c. | Per cent. of Bacteria. Liquefy gelatin | Nitrite =0 Ammonia=0 | Nitrite =0 Ammonia=+ | Nitrite =+ Ammonia=0 | Nitrite =+ Ammonia=+ |
|---|---|---|---|---|---|---|---|---|
| Station sewage.. | Jan. 1 | ..... | 5,250,000 | 4 | 64 | 0 | 0 | 36 |
| " " .. | " 22 | ..... | 3,900,000 | 4 | 35 | 25 | 12 | 28 |
| " " .. | Feb. 12 | ..... | 3,100,000 | 6 | 62 | 38 | 0 | 0 |
| Eff. Filter 1.... | Jan. 22 | ..... | 520,000 | 5 | 41 | 17 | 28 | 14 |
| " 4.... | " 1 | ..... | 75 | 7 | 93 | 0 | 0 | 7 |
| " 5.... | Feb. 13 | ..... | 8,100 | 9 | 51 | 30 | 0 | 19 |
| " 6.... | Jan. 22 | ..... | 35,500 | 1 | 53 | 35 | 11 | 1 |
| " 9.... | " 1 | ..... | 270,000 | 1 | 50 | 13 | 12 | 25 |
| " 9.... | " 22 | ..... | 195,000 | 13 | 37 | 25 | 0 | 38 |
| " 10.... | Feb. 13 | ..... | 6,200 | 8 | 80 | 0 | 0 | 20 |
| Eff. Filter 226... | Jan. 27 | ..... | 8,500 | 35 | 10 | 82 | 0 | 8 |
| " 227... | " 27 | ..... | 1,300 | 38 | 21 | 59 | 10 | 10 |
| " 228... | " 27 | ..... | 2,700 | 15 | 45 | 55 | 0 | 0 |
| Sand, No. 1..... | Dec. 14 | 2 ins. | 1,400,000 | ... | 40 | 30 | 10 | 20 |
| " 9..... | " 14 | 2 ins. | 2,300,000 | ... | 30 | 20 | 0 | 50 |
| " 213..... | " 14 | 2 ins. | 1,100,000 | ... | 40 | 20 | 10 | 30 |
| Sand, No. 1..... | Jan. 26 | 4 ins. | 9,725,000 | 1 | 33 | 33 | 0 | 34 |
| " 9..... | " 26 | 4 ins. | 40,000,000 | 1 | 65 | 23 | 0 | 12 |
| " 213..... | " 26 | 4 ins. | 16,000,000 | 5 | 0 | 16 | 0 | 84 |
| Sand, No. 9..... | Jan. 14 | Surf. | 460,000,000 | 6 | 27 | 33 | 0 | 40 |
| " 9..... | " 14 | 12 ins. | 1,500,000 | 20 | 56 | 17 | 9 | 27 |
| " 100..... | " 14 | Surf. | 6,400,000 | 4 | 98 | 0 | 0 | 2 |
| " 100..... | " 14 | 12 ins. | 150,000 | 21 | 66 | 1 | 13 | 20 |

*The quantitative studies were well under way when Chester's bulletin on the Bacteriological Analysis of Soils (Bull. No. 65, Del. College Agr. Exp. Sta., March, 1904) appeared, in which an expression called the "Ammonifying Coefficient" was proposed, which expression appeared to be directly applicable to our own results and suggested the other expressions we have proposed.

aliquot portion of the whole number of colonies. These broth cultures are incubated for two days at 20° C. and agar streak cultures are inoculated from them. The agar streak cultures are incubated from two to four days at 20° C., the longer period being necessary in some instances with slow-growing cultures. Tubes containing respectively 0.1 % of pepton in distilled water and the same pepton solution plus potassium nitrate equivalent to 10 parts nitrogen per 100,000 are inoculated from each of the agar streaks. These cultures are incubated at 20° C. for seven days, after which the cultures in the plain pepton solution are tested for the amount of nitrogen present as ammonia, and the nitrate pepton solution cultures are tested for the amount of nitrogen present as nitrates, nitrites and ammonia. By subtracting the ammonia reading in the pepton solution from the ammonia reading in the nitrate pepton solution the amount of ammonia formed from the nitrate can be estimated. By subtracting the amount of nitrates in the culture from the amount originally present we obtain the total loss of nitrate, and by subtracting the sum of the nitrites and the estimated ammonia formed from the nitrates, from the total loss of nitrate, we obtain a value for the amount of nitrogen unaccounted for which has probably passed off as free nitrogen. The error of the methods is considerable and no figures have been used closer than 0.1 part of nitrogen per 100,000.

The methods for the quantitative determination of ammonia, nitrates and nitrites in these solutions have varied somewhat from the procedure usual in water analysis. For the ammonia determination, 1 cu. cm. of the solution is diluted with ammonia free water and nesslerized direct. The nitrites are determined as usual, 1 cu. cm. of the solution being mixed with nitrites free water and determinations made by the Griess method. The nitrates are determined by evaporating 1 cu. cm. of the solution to dryness in small tubes, treating with phenol-disulphonic acid and ammonia and reading as usual.

### METHOD OF DETERMINING THE LIQUEFYING POWER.

To determine the liquefying power, the agar streak cultures which have been used for the determination of the ammonifying power and denitrifying power are employed. Tubes of about 10 mm. diameter, containing about 100 mm. in depth of standard gelatin, are inoculated on the surface with a large drop of the fluid culture from the water of condensation at the bottom of the agar streak, care being taken to spread this fluid culture over the whole surface of the gelatin. A mark is now made on the outside of the tube at the surface line of the gelatin, and the cultures incubated for seven days at 20° C. With cultures inoculated in this manner the growth should spread over the whole surface of the gelatin and any liquefaction which may take place should proceed directly downward from the whole surface, giving us a stratiform liquefaction. It is any easy matter now to measure the amount of liquefaction, or in this case the depth of the liquefaction in millimeters, the reading being taken from the mark showing the original surface of the gelatin since some of the liquefied matters may have evaporated. The gelatin cultures should be made in duplicate and the two liquefaction readings should be averaged to obtain the correct liquefying power of the culture.

### ACCURACY OF THE METHODS FOR DETERMINING THE AMMONIFYING, DENITRIFYING AND NITROGEN-LIBERATING POWERS.

In order to determine the accuracy of the methods of estimating the ammonifying, denitrifying and nitrogen-liberating coefficients, special cultures representing the various types of change noted in the nitrogen content of solutions were selected from the cultures used in determining the values expressed in Table III. In all, about 30 of these cultures have been studied, the method employed being to inoculate bottles containing about 100 cu. cm. of the usual pepton solution and of the nitrate pepton solution with these cultures and to make daily readings of the loss of nitrates, of the amount of nitrites and of the amount of ammonia in the nitrate pepton solution and of the amount of ammonia in the pepton solution. The detailed data concerning all of these cultures would, however, be too large for insertion here.

Of the cultures which produced any ammonia at all from the pepton, 93% showed ammonia before the seventh day. The maximum amount of ammonia produced in seven days was 2.4 parts and the maximum amount produced in ten days was 10.0 parts per 100,000. The average amount produced in seven days was 49% of the amount produced in 14 days.

Of the cultures which reduced nitrates, 75% caused a reduction before the seventh day, the maximum amount of nitrates reduced in seven days by any culture being 9.0 parts, which figure was also the maximum reduction for 14-day incubation. The average nitrate reduction in seven days was 51% of that reduced in 14 days. Many interesting facts have been noted in the behavior of different cultures. Some cultures have appeared to cause the reduction of nitrates to nitrites, ammonia and nitrogen to take place simultaneously, while others have apparently caused the reduction to go on by stages; first, a complete reduction of the nitrates to nitrites, then a reduction of the nitrites to ammonia and finally total loss of the nitrogen, as shown by the usual tests. In some instances, considerable amounts of nitrogen would be unaccounted for during the early stages of the reduction, which would be found later when the reaction was complete. This may indicate intermediate products between the nitrates, nitrites and ammonia, which at present we are unable to determine by our usual tests.

Studies of the constancy of the method with duplicate cultures are not yet sufficiently complete to allow of any conclusions being drawn from them. It is believed, however, that the constancy will be fairly good, the variation being well within the limits of accuracy of the chemical and biological methods employed.

### ACCURACY OF THE METHOD OF DETERMINING THE LIQUEFYING POWER.

Studies of the liquefying power as determined by this method with 25 cultures showed that two cultures, or 8% of the cultures examined, did not liquefy until after the seventh day.

Comparing the amount of liquefaction as determined on the seventh and fourteenth day, we find that the liquefaction obtained on the seventh day was 60% of that which was obtained on the fourteenth day, the maximum seven-day reading being 76% of the 14-day reading.

Comparing the results obtained with duplicate cultures, we find that 33% of the cultures showed no deviation from the mean of the duplicate readings, the average deviation of the readings from the mean reading being 8% and the maximum deviation from the mean reading being 20%.

### METHOD OF COMPUTING THE AMMONIFYING, DENITRIFYING AND LIQUEFYING COEFFICIENTS.

The liability of the organic matter in liquid such as sewage to undergo chemical changes due to the action of bacteria depends on the number of bacteria coming in contact with this matter and upon the ability of the various types of bacteria to cause these changes.

Thus the liability of a change in the character of the liquid by the action of its bacterial contents is called the potential of the liquid, and the ability of the material within a filter to cause changes in a sewage coming in contact with it by virtue of the bacteria which have found lodgment on its particles is called the potential of the filtering material. A high potential always means large numbers of bacteria at work combined with large ability of the individual bacteria to perform that work. On the other hand, low potential may mean low numbers of bacteria at work combined with small ability of those bacteria to perform the work, or it may mean large numbers of bacteria having comparatively very little ability to perform the necessary chemical changes. All grades exist between high and low potential, each being dependent on the number of bacteria at work and on their ability to perform that work.

The quantitive expression of the potential is called the coefficient: thus the ammonifying coefficient of a sample is an expression of the total ability of the bacteria in that sample to produce ammonia from organic matter (pepton); the denitrifying coefficient is the total ability to reduce nitrates; the nitrogen-liberating coefficient is the total ability of the bacteria to set free nitrogen from nirates and nitrites, and the liquefying coefficient is the total ability to liquefy albuminous matters. The computation of these coefficients from the biochemical results obtained by the methods previously explained, is as follows:

**Each culture** represents an aliquot portion of the total number of bacteria in the sample under analysis, and the amount of ammonia produced by this culture (expressed as parts of nitrogen per 100,000) in a solution containing 0.1% of pepton (Witte) in seven days at 20° C. is the ammonifying power of that culture. The ammonifying power of the culture multiplied by the estimated number of bacteria of that type in the sample expressed as millions of bacteria becomes the ammonifying coefficient of that type of bacteria for that sample, and the sum of the ammonifying coefficients of all the types from a given sample becomes the ammonifying coefficient of that sample.

The calculation of results may be simplified by multiplying the ammonifying power of the culture by the number of colonies which the colony represents and then multiplying the sum of these products by the dilution and dividing by one million. This is best illustrated by the following example showing the calculation of the ammonifying power of a sample of the effluent from Filter 6, collected July 1, 1904, which is included in Table III.:

Gelatin plate = 45 colonies × dilution 1/50 = 2,250 bacteria per c. c.

Ten colonies fished as follows:
Culture No. 1, representing 3 mottled gray liquefiers.
" 2 " 2 small white neuclei in clear liquefaction.
" 3-10 inclusive, each representing 5 small white non-characteristic colonies.

| Culture No. | Ammonia reading. | | No. of colonies. | | |
|---|---|---|---|---|---|
| 1 | 1.9 | × | 3 | = | 5.7 |
| 2 | 2.2 | × | 2 | = | 4.4 |
| 3 | 1.0 | × | 5 | = | 5.0 |
| 4 | 0.0 | × | 5 | = | 0.0 |
| 5 | 0.0 | × | 5 | = | 0.0 |
| 6 | 0.1 | × | 5 | = | 0.5 |
| 7 | 0.1 | × | 5 | = | 0.1 |
| 8 | 1.9 | × | 5 | = | 9.5 |
| 9 | 0.8 | × | 5 | = | 4.0 |
| 10 | 1.0 | × | 5 | = | 5.0 |

$$\frac{34.6 \times (\text{dilution} - 50)}{1{,}000{,}000} =$$

.00173, = Ammonifying coefficient of sample.

The denitrifying coefficient is obtained in a similar manner. The nitrate-reducing power of each culture is the difference in the amount of nitrates present in the nitrate pepton solution at the time of inoculaion and after seven days' incubation at 20° C. expressed as parts of nitrogen per 100,000, multiplied by the number of millions of bacteria of that kind. The nitrate-reducing coefficient or denitrifying coefficient of the sample then becomes the sum of the denitrifying coefficients of all the types of bacteria in the sample under examination.

The nitrogen-liberating coefficient of each type of bacteria is obtained by multiplying the estimated amount of nitrogen liberated from the nitrate solution, expressed in parts per 100,000, by the number of bacteria of that type expressed as millions of bacteria. The nitrogen-liberating coefficient of the sample then becomes the sum of the nitrogen-liberating coefficients of the various types of bacteria in the sample.

The liquefying coefficient type of bacteria is obtained by multiplying the liquefying power of each culture by the number of millions of bacteria of that type in the sample and the liquefying coefficient of the sample becomes the sum of the liquefying coefficients of the different types of bacteria in the sample.

### APPLICATION OF THE BIOCHEMICAL METHODS TO THE STUDY OF SEWAGE AND THE EFFLUENTS FROM SEWAGE FILTERS.

The practical application of these methods of analysis appears to be, first, in the study of the bacteria upon the material in the different types of sewage filters to explain why in some instances

one filter will give so much better purification than another filter of exactly the same type and operated in the same manner; and, second, in the study of the sewages and the effluents from sewage filters.

In the case of sewage it is quite probable that a series of determinations of the various coefficients would throw much light on the question as to why some sewages are more easily purified than others of apparently the same chemical composition. A high potential sewage, that is, one having high ammonifying and liquefying coefficients, should be more readily purified than a sewage of low potential, and if further experiments show this to be true the information obtained by the determinations of these coefficients might become of considerable importance in the planning of new sewage purification plants. In the examination of the effluents of sewage filters, the methods should also yield valuable information, indicating the changes which are going on in the filter and the condition of the effluent as regards ability for self-purification when turned into a water course. Much of this can, of course, be determined by chemical methods, but these bacterial methods may become an important adjunct.

During the first six months of 1904 a considerable number of sewages and sewage effluents were examined by these methods. Inspecting the results of these examinations, as presented in Table III., it will be noted first that there is considerable variation in the coefficients as determined for the sewage, and also that the coefficients as determined for the Andover sewage are much greater than those determined for the Lawrence sewage. Taking the septic sewages, we find in both Septic Tanks A and D-1, in which the sewage at this time was receiving from 20 to 24 hours storage, that there is considerable increase in the ammonifying coefficients over those determined for the sewage entering the tanks, although the denitrifying and nitrogen-liberating coefficients for Septic Sewage A were lower than those of the sewage entering the tank, the reverse being true of the sewage flowing from Septic Tank D-1. With the septic sewages D-1, D-2, D-3, D-4 and D-5, which were receiving respectively one, two, three, four, and five days' storage in the septic tank, an interesting fact is noticed in that both ammonifying, denitrifying and nitrogen-liberating coefficients were steadily reduced with increased storage. Comparing the effluents of contact Filters 103, 175 and 176 with the effluents of intermittent continuous Filters 135, 136 and 189, the variation in free ammonia as determined by chemical analysis agrees fairly well with the variation in the ammonifying coefficients. In these two types of filters the nitrate-reducing and nitrogen-liberating coefficients of the contact filters, in which the action is more or less anærobic, are many times higher than those of the intermittent continuous filters, in which the action is almost entirely aerobic. This can, of course, be shown by chemical analyses of the effluents.

Comparing the biochemical and chemical analyses of samples from the out-of-door Filters 1 to 10, inclusive, collected during the winter months, we find in nearly every case high ammonifying coefficients accompanied by high free ammonia as determined by chemical analysis and high denitrifying coefficients combined with considerable free ammonia and nitrites and low nitrates.

Comparing the results obtained from these winter samples with the results obtained from samples examined during the latter part of June and the early part of July, when the filters had recovered from the cold weather and were doing first-class work, we find that the effluents from Filters 1, 2, 5B, 6 and 9A, which showed some ammonifying power when examined in the winter, had lost this power when nitrification had become more active within them. The effluents from Filters 1, 2, 5B, 6 and 9A all showed considerable power to reduce nitrates and liberate nitrogen during the cold weather, but such power was lacking when examined again in warm weather. The effluents from Filters 4 and 10, which continued to nitrify actively during the winter, did not show any ammonifying, denitrifying or nitrogen liberating powers either winter or summer.

These results are further confirmation that during exceptionally cold weather the nitrifying bacteria are more or less inactive and that much of the change going on in a filter is accomplished by bacteria of other types which are apparently capable of performing their work at low temperatures. The results of the determinations of the various coefficients together with a portion of the chemical analyses of the same samples are shown in Table III.

The coefficients expressed for samples examined during January, February and March are subject to errors caused by the gradual change and improvements which were taking place in the methods of determining these factors.

## SUMMARY AND CONCLUSIONS.

The amount of purification which a sewage will undergo in a given time depends on the number of bacteria at work and on the power of the individuals to perform that work, the process of purification being accomplished by the bacteria present in the sewage working jointly with the bacteria which have found lodgment on the filtering materials. The chemical changes which take place in the sewage in the process of purification may be divided into three groups: (1) putrefaction—that is, the breaking down of the complex organic matter into simpler forms; (2) nitrification and oxidation—that is, the oxidation of the nitrogenous matter into nitrites and nitrates, and of carbonaceous matter into carbonates; (3) denitrification—that is, the breaking down of nitrates and nitrites into ammonia and free nitrogen.

These three processes probably all go on to a greater or less extent in sewage filters of all the various types. If a filter is so constructed and operated that oxidizing processes are active throughout the entire depth the reduction of nitrates is prevented and practically all the nitrogen in the applied sewage will appear in its effluent. If, however, the construction and operation of a filter is such that both oxidizing and reducing actions occur, much nitrogen will be lost.* The effluents of intermittent continuous filters in good operation contain practically all the nitrogen applied, while the effluents of contact filters in good operation show a large disappearance of nitrogen. From these results we should conclude just what is shown by the biochemical examination of the effluents of these various classes of effluents. It was found that the effluents from the contact filters, in which a considerable amount of reducing action takes place, showed denitrifying and nitrogen-liberating coefficients many times greater than those obtained for the effluents of the trickling filters in which conditions are always favorable for oxidation and nitrification.

The effluents of intermittent sand filters in good operation also contain a large portion of the nitrogen applied. During the cold weather, however, nitrification may become inert in filters of this type, and while the effluents may remain fairly good in appearance, free ammonia and low nitrates will be given, combined with a considerable loss of nitrogen. In the biochemical examination of the effluents from sand filters located out of doors it was found that during the winter those filters which were giving unsatisfactory purification, as shown by small amounts of nitrates in the effluents, showed, as would be expected, great power to reduce nitrates and to liberate nitrogen, whereas in summer, when nitrification is active, these powers are very slight or entirely absent from these filters.

Studies of sands from filters in which nitrifica-

*See p. 213, Report Mass. State Board of Health for 1902.

TABLE III.—SHOWING RESULTS OF BIOCHEMICAL EXAMINATIONS OF SEWAGES AND THE EFFLUENTS FROM SEWAGE FILTERS.

| Sample. | 1904. | Bacterial and biochemical analysis. Bacteria per c.c. | Per cent. of bacteria liquefy gelatin. | Ammonifying coefficient. | Denitrifying coefficient. | Nitrogen-liberating coefficient. | Liquefying coefficient. | Chemical analysis. (Parts per 100,000.) Free Ammonia. | Nitrites. | Nitrates. |
|---|---|---|---|---|---|---|---|---|---|---|
| Station sewage | Feb. 25 | 2,350,000 | 8.5 | 0.28 | 2.03 | 1.83 | .... | 4.80 | ..... | .... |
| " | Mar. 8 | 5,650,000 | 1.8 | 0.61 | 1.96 | 0.70 | .... | 3.50 | ..... | .... |
| " | June 27 | 1,750,000 | 7.0 | 1.08 | 6.70 | 2.14 | ... | 6.60 | ..... | .... |
| Sewage for Septic Tank A | Feb. 29 | 4,500,000 | 3.3 | 1.18 | 6.62 | 5.38 | .... | 3.80 | ..... | .... |
| Septic Sewage A | " 29 | 2,700,000 | 2.8 | 1.39 | 5.14 | 3.27 | .... | 4.00 | ..... | .... |
| Sewage for Septic Tank D | Mar. 24 | 4,150,000 | 2.4 | 0.65 | 2.65 | 1.32 | .... | 4.90 | ..... | .... |
| Septic Sewage D—1 | " 24 | 4,150,000 | 6.1 | 1.47 | 2.88 | 1.74 | .... | 7.00 | ..... | .... |
| " D—2 | " 24 | 1,000,000 | 10.0 | 0.45 | 1.43 | 1.14 | .... | 6.50 | ..... | .... |
| " D—3 | " 24 | 860,000 | 9.3 | 0.56 | 1.35 | 0.88 | .... | 6.50 | ..... | .... |
| " D—4 | " 24 | 700,000 | 1.4 | 0.50 | 0.75 | 0.59 | .... | 5.80 | ..... | .... |
| " D—5 | " 24 | 1,300,000 | 4.6 | 0.22 | 1.60 | 0.53 | .... | 5.50 | ..... | .... |
| Andover sewage | June 9 | 3,000,000 | 7.0 | 1.51 | 13.43 | 6.98 | 2.21 | 3.30 | ..... | .... |
| Effluent of Filter 103 | Mar. 16 | 590,000 | 7.6 | 0.20 | 1.02 | 0.31 | .... | 1.56 | .0070 | 0.51 |
| " " 175 | " 1 | 1,350,000 | 6.7 | 0.17 | 1.33 | 1.21 | .... | 0.86 | .1000 | 4.10 |
| " " 176 | " 1 | 1,040,000 | 3.9 | 0.38 | 1.75 | 1.34 | .... | 3.20 | .0200 | 0.00 |
| Effluent of Filter 135 | Mar. 16 | 150,000 | 40.0 | 0.11 | 0.27 | 0.16 | .... | 0.46 | .0060 | 2.93 |
| " " 136 | " 16 | 250,000 | 40.0 | 0.67 | 0.67 | 0.56 | .... | 1.20 | .0100 | 2.09 |
| " " 189 | " 8 | 800,000 | 7.5 | 0.11 | 0.46 | 0.27 | .... | 2.81 | .0120 | 0.91 |
| " " 222 | June 9 | 1,650,000 | 6.0 | 0.63 | 4.88 | 2.78 | 1.42 | 3.00 | .0000 | 0.05 |
| Effluent of Filter 1 | Feb. 25 | 550,000 | 5.5 | 0.03 | 0.44 | 0.43 | .... | 4.16 | .0040 | 0.77 |
| " " 1 | July 1 | 3,000 | 7.0 | 0.00 | 0.01 | 0.00 | 0.04 | 0.04 | .0000 | 4.62 |
| " " 2 | Feb. 25 | 21,300 | 2.2 | 0.00 | 38.46 | 0.03 | .... | 1.75 | .0048 | 0.07 |
| " " 2 | July 6 | 20 | 45.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.75 | .0104 | 4.28 |
| " " 4 | Feb. 25 | 43 | 46.4 | 0.00 | 0.00 | 0.00 | .... | 0.03 | .0006 | 1.18 |
| " " 4 | July 1 | 60 | 3.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.70 | .0004 | 5.38 |
| " " 5 | Feb. 25 | 300,000 | 10.0 | 0.07 | 0.21 | 0.17 | .... | 2.90 | .0100 | 1.60 |
| " " 5 | July 1 | 1,500 | 17.0 | 0.00 | 0.00 | 0.00 | 0.01 | 0.30 | .0004 | 7.14 |
| " " 6 | Mar. 11 | 82,500 | 8.5 | 0.04 | 0.12 | 0.11 | .... | 3.20 | .0020 | 0.84 |
| " " 6 | July 1 | 2,250 | 11.0 | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 | .0002 | 5.24 |
| " " 9 | Mar. 11 | 100,000 | 10.0 | 0.01 | 0.13 | 0.06 | .... | 2.00 | .0060 | 2.22 |
| " " 9 | June 27 | 18 | 100.0 | 0.00 | 0.00 | 0.00 | .... | 0.02 | .0000 | 3.75 |
| " " 10 | Mar. 11 | 6,800 | 22.2 | 0.00 | 0.01 | 0.01 | .... | 4.60 | .0026 | 3.57 |
| " " 10 | July 1 | 75 | 58.0 | 0.00 | 0.00 | 0.00 | 0.01 | 0.03 | .0202 | 5.85 |
| " " 100 | Mar. 1 | 80,000 | 5.6 | 0.07 | 0.04 | 0.02 | .... | 0.96 | .0060 | 0.77 |

tion was active and from others in which nitrification was not active show that the sands from the latter filters are able to induce a rapid and complete reduction of large amounts of nitrates, while sands from filters which are actively nitrifying do not cause this denitrification, and, further, studies of the bacteria in these sands and in the effluents from these filters show that a very considerable portion of the bacteria in the filters in which nitrification is not active are able to reduce nitrates to nitrites and ammonia quite readily, while the reverse is true of the bacteria from filters in which nitrification is active.

The ordinary methods of bacterial analysis do not yield information concerning the part which the various types of bacteria play in the process of purification. The present studies have been devoted to finding methods by which these functions may be determined and to the expression of these functions in such a manner that they may yield this information. In order to be of the most value it has been found that the determination of these functions must be approximately quantitative. Methods have been devised for the determination of the total power of the bacteria in a sample to produce ammonia from organic matter (ammonifying coefficient); of their power to reduce nitrates (denitrifying coefficient); and of their power to liberate nitrogen (nitrogen-liberating coefficient). So far the methods have been applied only to sewage and to the effluents of sewage filters, but they are also directly applicable to the study of the conditions of bacterial life in the material of the filters themselves.

## THE CHARLES RIVER DAM AND BASIN AT BOSTON AND CAMBRIDGE, MASS.

By J. Albert Holmes.*

In Engineering News of Oct. 6, 1904, appeared an article giving a general description of the dam and lock to be constructed in the Charles River, in the cities of Boston and Cambridge, Mass.

The main portion of the dam is to be composed of earth filling between masonry retaining walls, supported on pile foundations and extending to and connecting with existing walls; its lower face will coincide, substantially, with the lower side of the existing Craigie Bridge.

The plans and specifications were completed and the work advertised about the middle of November, and on Dec. 20 the bids were opened (see p. 310 of our Construction News Supplement for Dec, 29, 1904). The contract was awarded on Dec. 30, 1904, to the Holbrook, Cabot & Rollins Corporation, 6 Beacon St., Boston, Mass., for $801,608.

The following description treats principally of the foundations of the lock and sluices and the proposed shut-off dam and is taken in great part from the specifications for the dam and lock. The plans and sections shown are from the accompanying contract plans. Figs. 1 and 2 include a general plan, a profile and cross-sections. Fig. 3 shows the coffer dam and Fig. 4 the shut-off dam.

As a preliminary to the design and construction of the dam and lock, 63 wash borings were made on the proposed site, from which samples of earth were obtained and the thickness and location of the different strata determined. Nearly two thousand soundings, covering the whole site and extending beyond the foot of the proposed slopes, were taken to determine the contour of the bottom. The soundings were 25 ft. apart, each way, and were taken with weighted poles from a specially constructed raft, similar to the one used on the Delaware River work (Eng. News, of July 3, 1902).

Test piles were also driven, the resistance to driving through the different materials noted and the bearing power estimated. Most of the piles were afterward withdrawn to see what condition they were in. Four of the piles held so firmly that they could not be pulled with the apparatus at hand.

The wash borings developed hard bottom at varying depths consisting of clay; gravel and sand, overlaid by soft blue clay, stiff blue clay, coarse gravel and finally in the bed of the river, silt.

The silt will be removed wholly or in part from under the walls on the harbor and basin sides as will the material to a greater depth under the lock and sluices. The fill under the walls will be gravel. Broken stone will be placed under the lock.

The foundation piles under the retaining walls will not reach the hard bottom in all cases, nor is it considered desirable that they reach even the stratum of soft blue clay; to prevent this and to give sufficient bearing without penetrating into or approaching too near the layer of soft clay, sand will be deposited before the piles are driven.

### LOCK AND SLUICES.

The most important portions of the structure will be the lock (Figs. 1 and 2) at the Boston end of the dam and the sluices near the Cambridge shore. The lock will rest on a foundation of piles, except perhaps a portion at the basin end, where a small amount of ledge will be encountered.,

The lock itself will be built of concrete, reinforced with ¾-in. steel rods spaced 11 ft. c. to c., and 1⅛-in. rods spaced 8 ft. c. to c. The lock will have a total length of 492 ft. and an inside width of 45 ft.

The two gates will be metal caissons and are to roll into recesses in the side of the lock. The distance between centers of gates is 358 ft.

There will be 17 ft. of water on the lower gate sill at mean low tide. The mean range of tide is about 9.8 ft. This gives 26.8 ft. at mean high tide, but the available depth on the upper sill will be 21 ft., this sill being 3.4 ft. higher than the other and the water in the basin being maintained at an elevation about 2 ft. below mean high tide.

The specifications call for round piles of spruce, yellow pine, Norway pine, or oak for the foundations of the lock. The piles are to be driven after the coffer dam has been pumped out. Very careful studies and plans have been made for the coffer dams. The one around the lock (Fig. 3) will be especially difficult to maintain, as it will have to withstand, at times, a pressure due to the water reaching an elevation of over 40 ft. above the bottom of the excavation. There will be water on but three sides, however, and the land connections will be in favorable positions.

The contractor may substitute other designs equally good for the coffer dams, but he must bear the whole responsibility for their success in either case.

There will be constructed in the same coffer dam with the lock about 500 ft. of a 10 × 12-ft. marginal conduit, which will afterward be extended along the Boston shore of the basin.

The coffer dam at the Cambridge end of the dam will be a much smaller structure and will be in a more favorable position and less depth of water; it will also have water on but three sides. The land connections will be in equally good positions.

Within this coffer dam will be constructed a portion of a marginal conduit; also sluices for the purpose of discharging the flow of the river through the dam. One of the sluices will connect with the marginal conduit and another, with its top at a higher level than the others, will serve also as a lock for small boats. These sluices, together with two openings into the Boston marginal conduit near the basin end of the lock, will

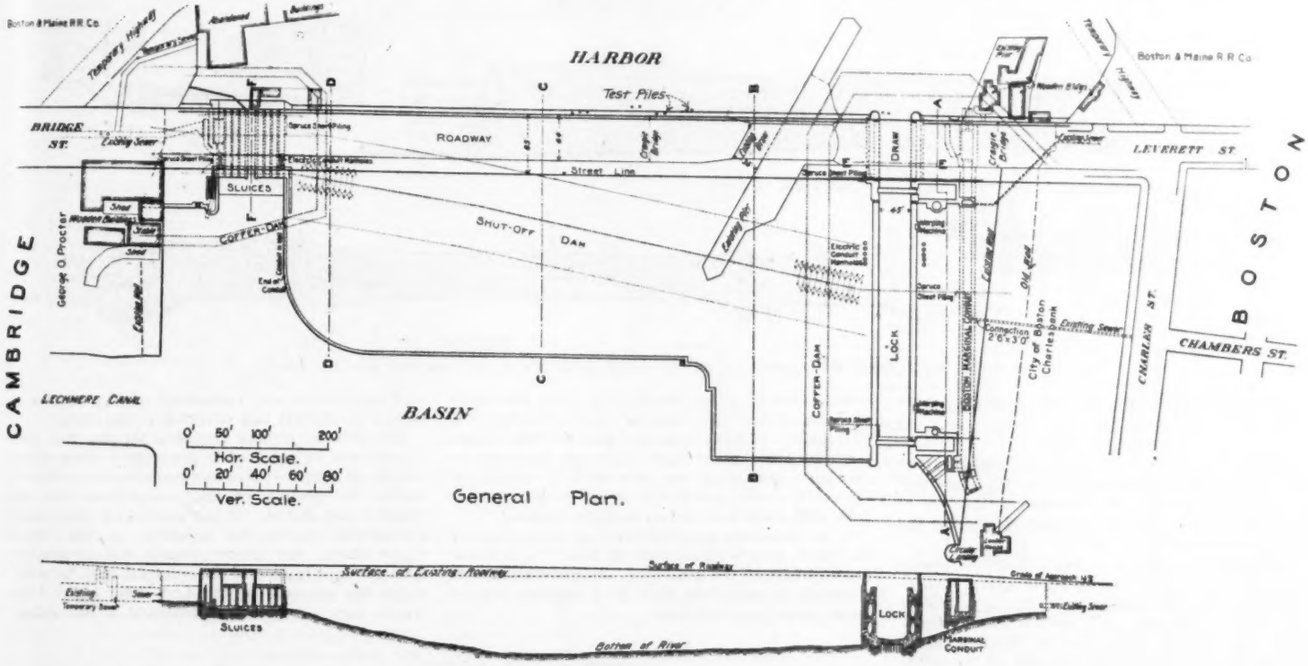


FIG. 1. GENERAL PLAN AND PROFILE OF CHARLES RIVER DAM, BOSTON AND CAMBRIDGE, MASS.

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be sufficient to discharge the estimated flood flow of the river.

The sluices will be of concrete reinforced with 1-in. iron rods. The harbor and basin ends of the sluices will be faced with granite. The westerly of the nine sluices, as mentioned above, will be connected with the Cambridge marginal conduit by means of tide gates, as will also the large storm drain in Bridge St.

SHUT-OFF DAM.

Perhaps the most interesting and difficult portion of the work, aside from the coffer dams and the locks and sluices, will be the construction of the shut-off dam and the method of making the final closure (see Figs. 1 and 4).

Extending from shore to shore, near the center of the dam, will be a line of sheet piling; underneath the lock and sluices it is simply a line of 6-in. spruce sheeting with yellow pine splines. There will be two other lines of sheeting under the lock extending from side to side of the coffer dam and three additional lines under the sluices. In the deep portion of the river, between the lock and sluices, the shut-off dam will be composed of bents of four round oak or yellow pine piles and two rectangular 8 × 10-in. yellow pine piles. The bents will be strongly braced within themselves and tied to each other. They will be about 41 ft. long and 8 ft. c. to c.

Special steel castings are to be provided for holding the waling pieces at the top of the sheet piling, which in this portion will be 6-in. grooved and splined yellow pine.

The vertical sheeting will be cut-off level at about 2.8 ft. below mean low water.

The rectangular piles will be bolted together to form grooves to receive stop-planks and will extend 15 ft. above the top of the sheet piling, or about 12.2 ft. above mean low water.

The lowest horizontal brace in each bent is about 7 ft. below mean low water; to get it into position without the aid of a diver it is proposed to fasten the two lower horizontal braces together above water with vertical and diagonal bracing, lower them to the desired position and wedge and bolt them in place.

The contractor may be required to place the rectangular piles forming the stop-plank grooves in one or more of three ways: He may be required to bolt them together and place them in position, without driving, before the filling above their lower ends has been deposited (these piles will not reach the present bed of the river); he may, after the filling has been raised above the elevation of the lower end of the piles, drive them, after being bolted together; or he may drive them separately, after the filling has been deposited.

As the work of driving the sheet piles and driving or otherwise placing the rectangular piles and securing them in place approaches completion the increased velocities of the tidal currents may prevent this work from being carried on except at certain stages of neap tides; and while this work of completion is in progress the contractor will be required to have sufficient pile-driving, dredging and other plant and tools and workmen to prosecute this work and the work of depositing the earth, coarse gravel and riprap at the shut-off dam with such rapidity as may be required.

It is especially reserved that at this stage of the work, if it is considered necessary to increase the strength of the structure, the dimensions and amounts of materials may be increased beyond those shown on the plans.

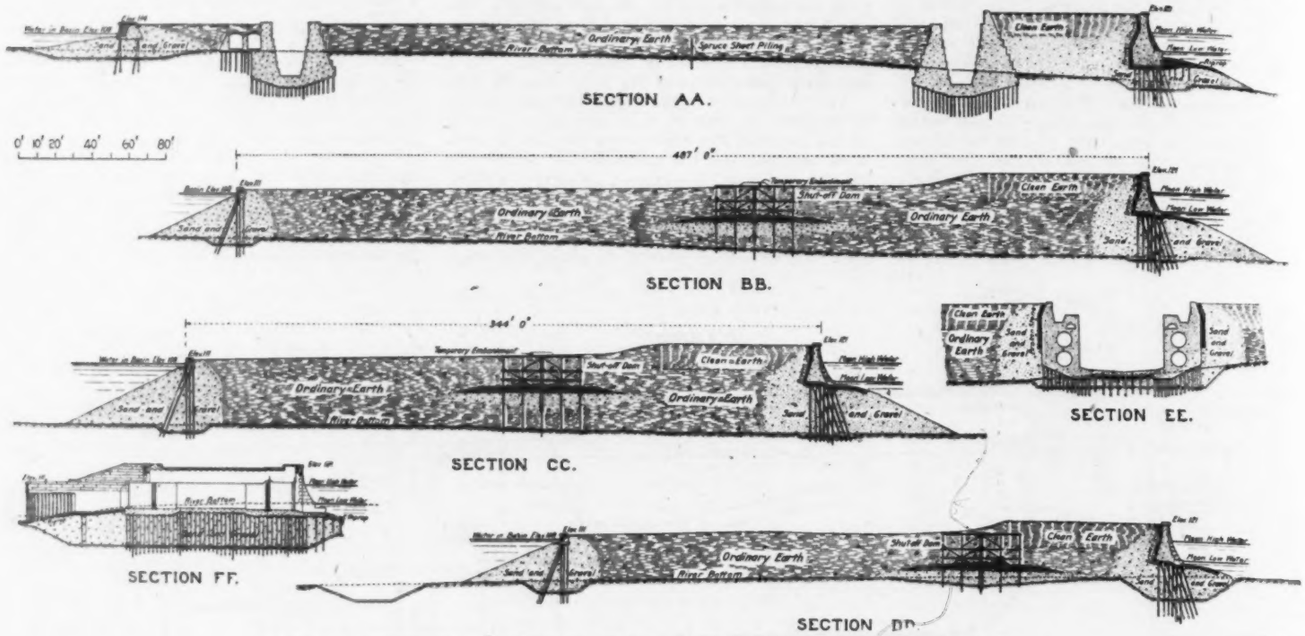


FIG. 2. SECTIONS OF CHARLES RIVER DAM AND LOCK, AS SHOWN IN FIG. 1.

Previous to placing the stop-planks, the contractor will be required to organize a force which will be of sufficient size and sufficiently trained to insure the placing of the stop-planks in the times above stated. If the contractor shall have placed the stop-planks properly in the times above stated, the commonwealth will be responsible for any failure of the shut-off dam to withstand the pressure of the first two high tides which come against it, but should it fail subsequently, the contractor will be responsible. Before the stop-planks are placed, the lock and sluices will have been completed and be in readiness to use.

A low neap tide will discharge the basin through the present cross-section at the site of the dam, to an elevation of about 1 ft. above mean

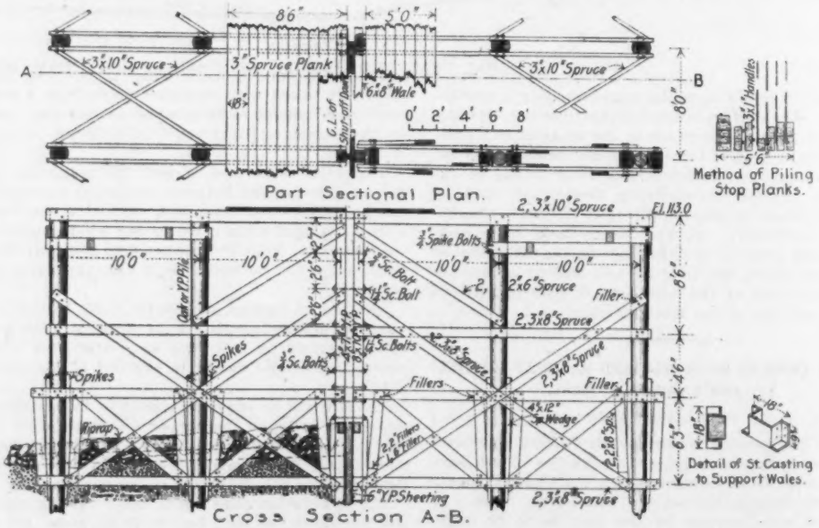


FIG. 4. DETAILS OF SHUT-OFF DAM.

In addition to the above special provisions in the contract for constructing the shut-off dam, the placing of the stop-planks is provided for as follows: The contractor will be required to put all the stop-planks in place between the first and second of four consecutive high neap tides, none of whose predicted heights, as shown by the tide tables of the U. S. Department of Commerce and Labor, are more than 9.5 ft. above mean low tide, and when the wind and weather are favorable. He shall begin placing the stop-planks a short time before low tide and shall have all of the planks below the level of the water in place before the tide begins to run up-stream at the dam, and shall place the remainder of the planks in season to prevent any overflow at the dam.

low water. The structures that will be in position at that time will prevent it from going as low as that, however.

A channel 350 ft. wide through the dam near the center of the river must be reserved till such time as the additional waterway of the lock or sluices is available for use. When they are both ready to use the filling may be placed in this channel and the shut-off dam completed. At present during a mean tide the maximum discharge is about 20,000 cu. ft. per sec. and the rate about 1 ft. per sec.

### MASONRY.

Concrete will constitute nearly 95% of the masonry portion of the dam. Concrete masonry will be used for the lock sluices, gate chambers, foundation and backing of the retaining walls, marginal conduits and connecting sewers.

Portland cement is to be used, equal in quality to the best American Portland. One barrel must weigh 380 lbs., and will be considered to contain by volume 3.6 cu. ft.

All cement will be inspected and carefully tested and the contractor will be required to have on hand at all times a sufficient supply to allow for 28-day tests.

The sand used must be clean and sharp and free from loam and pebbles. Either broken stone or screened gravel may be used, the greatest dimensions of which shall not be over 2½ ins. If the broken stone is otherwise clean, the contractor will not be required to remove the dust and fine materials, provided the amount which can be sifted through a screen having a mesh with a clear opening of ¼-in. does not exceed 15% of the volume screened. Should the dust and fine material exceed this amount, the surplus must be removed or the amount of sand diminished. The sand and stone are to be measured when not packed more closely than by throwing them in the usual way into the measuring box.

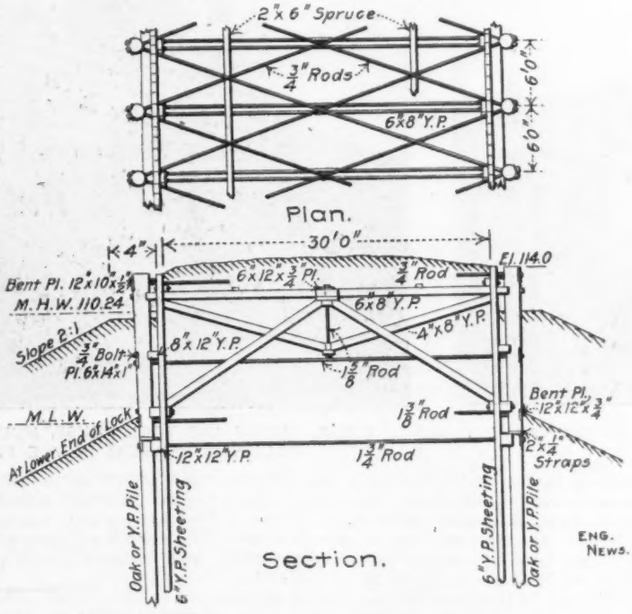


FIG. 3. DETAILS OF WIDE COFFERDAM.

Concrete to be deposited under water will be made in the proportion of 1:2:4, the latter to be either stone or gravel; that deposited above water either in the proportions of 1:2½:5; 1:3:6 or 1:5:9.

No concrete will be laid in water, nor will water be permitted to rise on it within 24 hours after it is placed, except where outside the cofferdam it is impracticable to do otherwise. No concrete masonry will be built between Nov. 15 and April 1.

Rubble masonry may be substituted for concrete in the backing of the retaining walls. The same price per cubic yard will be paid as for 1:2½:5 concrete.

Ashlar masonry will be used for the faces and copings of the retaining walls. The ring stones of arches, the architraves of door openings and the steps and copings at stairways will be of dimension stone.

There will be about 530 tons of cast iron, wrought iron and steel in different parts of the dam (the draw bridge and lock gates are not included in this contract) in the form of 60-in. and smaller sizes of pipes, valves, columns and beams in the gate chambers, manhole frames and covers, etc. There will be a large number of ducts, provided for electric power, telephone and telegraph wires.

The contract requires that work shall begin on the cofferdam at the Boston end of the dam not later than March 1, 1905, and that all work shall be finished by July 15, 1908.

Some of the principal items of work are: Two coffer dams; 340,000 cu. yds. of earth excavation and 390,000 cu. yds. of additional material for filling; 2,825 cu. yds. stone masonry; 41,000 cu. yds. concrete masonry; 470,000 lin. ft. of piles; 235,000 ft. B. M. long leaf yellow pine lumber; 555,000 ft. B. M. of spruce lumber; 9,700 tons of riprap.

## THE COPPER SULPHATE TREATMENT FOR ALGAE AT MIDDLETOWN, N. Y.

By James M. Caird,* Assoc. Am. Soc. C. E.

The City of Middletown, N. Y., obtains its water supply from three impounding reservoirs, Monhagen, Highland and Shawangunk, which are located some distance from the city. The water is filtered before being delivered to the consumers.

The filter plant has a capacity of 4,000,000 gallons per day, consists of four gravity and four pressure Continental filters, each set of 2,000,000 gallons capacity per day.

The water from Monhagen reservoir is used in the lower parts of the city and is passed through the gravity filters, while the elevated section uses the water from Highland reservoir after passing through the pressure filters. The water from Shawangunk reservoir discharges into Monhagen reservoir.

In recent years, during warm weather, considerable trouble has been experienced by algae growths; not only by the odor which they produced, but also by the rapid "clogging" of the filters. At times the filters would require washing at intervals of four to five hours.

From a sanitary standpoint the quality of these waters is good, the drainage area being owned or controlled by the water department.

MONHAGEN RESERVOIR.—The Monhagen reservoir, which was constructed in 1867, was the first to be treated with the copper sulphate; the reason being that the greater part of the city's supply is obtained from this source. This reservoir has a drainage area of 300 acres, surface area of 68 acres and a capacity of 296,000,000 gallons. When treated this reservoir contained 250,000,000 gallons. The copper sulphate was applied at the rate of 1 part to 3,333,000 parts of water.

Portions of this reservoir were covered with a heavy growth of Potamegeton (pond weed). Three days after the treatment this weed began to come to the surface and was raked off. Upon investigation it appeared to have rotted at the root. The conditions in this reservoir permitted a very uniform application of the copper sulphate. No fish were killed although they were present in large numbers.

The labor required for this treatment was the services of three men for 4 hours and 40 minutes each; three boats were used. Each man on an average covered 4.53 acres and treated 19,066,000 gallons per hour.

The examination of this water before and after the treatment revealed the following organisms:

| | Before. | 14 days after. |
|---|---|---|
| DIATOMACEAE—Synedra | 2 | |
| Nitzschia | 4 | 1 |
| CHLOROPHYCEAE—Ulothrix | 6 | |
| Closterium | 3 | |
| CYANOPHYCEAE—Oscillaria | 6 | |
| Anabaena | 15 | |
| SCHIZOMYCETES—Leptothrix | 2 | |
| Crenothrix | 2 | |
| MISCELLANEOUS—Picrsonema | 1 | |
| Nothoica | 2 | |
| Total per cu. cm | 43 | 1. |
| Bacteria per cu. cm | 420. | 450. |

The odor from this water before treatment was noticeable at a considerable distance from the reservoir.

SHAWANGUNK RESERVOIR.—This reservoir was constructed in 1902 and has a drainage area of 422½ acres, a surface area of 101 acres and a capacity of 434,000,000 gallons. There is a large quantity of decaying wood in this reservoir, as the stumps were not removed before the land was flooded. No growth of Potamegeton was shown.

It was very difficult to treat this reservoir in places, owing to the stumps. In going around the stumps the copper sulphate was applied a little stronger than in other parts of the reservoir. The consequence was the death of a few fish.

I should judge that in the vicinity of the stumps the copper sulphate was applied at the rate of 1 part to 1,500,000 parts of water. At the time of the copper sulphate treatment this reservoir contained 350,000,000 gallons; the copper sulphate was applied on the average of 1 part to 2,160,000 parts of water. The time of three men 11 hours each was required to apply the copper sulphate. Each man on an average covered 3.06 acres and treated 9,242,000 gallons per hours.

The organisms found in the water before and after treatment were as follows:

| | Before. | 10 days after. |
|---|---|---|
| DIATOMACEAE—Nitzschia | 8 | 1 |
| CHLOROPHYCEAE—Ulothrix | 10 | 1 |
| Protococcus | | 1 |
| CYANOPHYCEAE—Oscillaria | 14 | |
| Anabaena | 12 | |
| SCHIZOMYCETES—Leptothrix | 9 | 2 |
| Total per cu. cm | 53. | 5. |
| Bacteria per cu. cm | 300. | 260. |

HIGHLAND RESERVOIR.—This reservoir was completed in 1891, has a drainage area of 341 acres, a surface area of 110 acres and a capacity of 560,000,000 gallons. When treated the reservoir contained 495,000,000 gallons. The copper sulphate was applied at an average rate of 1 part to 2,292,000 parts of water.

There are a large number of "coves" around this reservoir which necessitated a stronger treatment, resulting in the killing of a few fish. I should estimate the strength of the copper sulphate in these localities at about 1 part to 1,250,000 of water.

The services of three men 12 hours each were required for this application. Each man on an average covered 3.05 acres and treated 13,750,000 gallons per hour.

As in Monhagen, this reservoir contained a growth of Potamegeton which broke off after treatment and came to the surface, where it was raked off.

The organisms found before and after treatment follow:

| | Before. | Six days after. |
|---|---|---|
| DIATOMACEAE—Nitzschia | 7 | 1 |
| CHLOROPHYCEAE—Protococcus | 34 | 3 |
| CYANOPHYCEAE—Oscillaria | 5 | |
| SCHIZOMYCETES—Leptothrix | 5 | 1 |
| ROTIFER—Microcodon | 10 | |
| Nothoica | 1 | |
| R. vulgaris | 1 | |
| Total per cu. cm | 73. | 5. |
| Bacteria per cu. cm | 400. | 360. |

The temperature of these waters at the time of treatment was about 68°F. The greatest trouble with the waters commenced about the middle of August. The copper sulphate was applied the first part of September, since which time the waters have given no trouble.

The destruction of the algae in waters which are to be filtered by the mechanical process re-

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sults in a great saving in the cost of operation. That is, after treatment less coagulant is required to free the water from the suspended matter, the period between the washings of the beds is longer and there is a reduction in the percentage of wash water.

The freeing of the reservoirs of the growth of Potamegeton was also very desirable, because after its death, which occurs during cold weather, it decomposes and imparts a very distinct yellowish brown color to the water.

The beneficial results were noticeable 24 hours after the application of the copper sulphate to these waters. Samples of water (1,000 cu. cm. each) taken from the reservoirs twelve hours after the application of the copper sulphate failed to give the copper reaction. This showed that the copper had been entirely absorbed. One treatment of each reservoir was all that was required. The total average amount of copper sulphate used was 1 part to 2,417,000 parts of water. The total amount of water treated was 1,095,000,000 gallons. The cost of this treatment was as follows:

| | |
|---|---|
| Copper sulphate, freight and cartage | $186.06 |
| Cartage of boats | 5.00 |
| Labor, 83 hours, at 15 cts. per hour | 12.45 |
| | $203.51 |

Exclusive of examinations and supervision, this was at the rate of 18½ cts. per 1,000,000 gallons of water treated.

FIG. 1. INGERSOLL-SERGEANT BAR CHANNELER, HUEYAPAM QUARRIES, MEXICO.

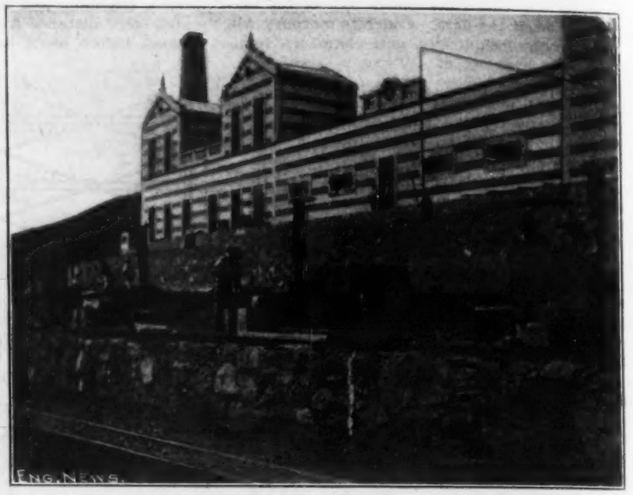


FIG. 2. ENGINE AND TOOL HOUSE, HUEYAPAM QUARRIES; PNEUMATIC HAMMERS IN THE FOREGROUND.

## A MODERN QUARRY PLANT IN MEXICO.

A representative instance of the growing adoption of American machinery and methods in the Mexican Republic is the recent equipment of the Hueyapam Quarries, located near the town of Otumba, distant about an hour's ride on the Mexican Railway from the City of Mexico. The quarries constitute one of many enterprises conducted on the Hacienda de Hueyapam, the property of Senor Ignacio Morales y Benitez, of Puebla.

The properties are somewhat remote from the main line of the railway, and to facilitate the delivery of product, a private narrow gage railway about 5½ miles long has been built, connecting with the Mexican Railway at a local station. There is a steady down grade from the Hacienda, and loaded cars descend by gravity. The empty trains are hauled back by mules. At the junction with the main line, a transfer station has been erected, with powerful derricks and other facilities for the transfer of stone from car to car. The quarry product is delivered direct to private yards in Mexico City, from which it is distributed as required.

The quarries are located on a hill at an elevation of about 8,500 ft. The principal output is dimension stone for building and monumental work. This stone is a pale pink sandstone, remarkably fine in grain, and uniform in quality. It lends itself not only to ordinary masonry work, but also to ornamental carving. Tests have shown a crushing strength of 7,520 lbs. per sq. in., and the average weight is 137 lbs. per cu. ft.

The quarry department building is a large substantial structure of the native stone, containing, beside the power plant, the offices and drafting room, machine shop, blacksmith shop, tool room and store room for duplicate parts. On the second floor are quarters for the engineers and mechanics.

The power plant includes a 100-HP. tubular boiler of English make, furnishing steam to the air compressor in the engine room, as well as to pumps, hoist, channelers and drills in the quarry workings. The air compressor is of the straight-line type, built by the Ingersoll-Sergeant Drill Co., of New York. Its size is 12-in. and 12¼-in. × 14-in., and at 155 revolutions per minute its free air capacity is 285 cu. ft. per min.

Steam from the main boiler plant drives two Ingersoll-Sergeant bar channelers, making the cuts in the formation which at the present time lies at an inclination of about 34° from the horizontal. In making the short cuts Ingersoll-Sergeant drills mounted on quarry bars drill the holes for "plug and feather" breaking. The same method is used in loosening the blocks from the bed. For handling the quarry product, a tubular steel jib crane is employed with a capacity of 10 tons at rapid hoisting speed. Dimension stone is loaded direct from quarry to car.

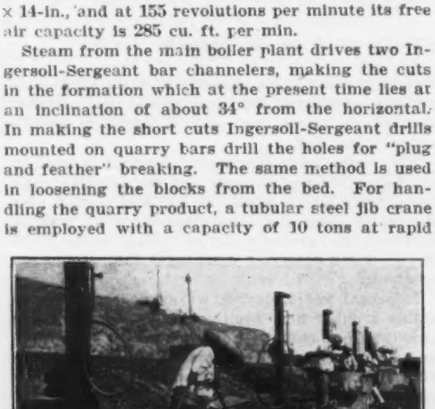


Fig. 3. Dressing and Carving Stone with Ingersoll-Haesler Pneumatic Hammers; Hueyapam Quarries, Mexico.

Extending along the front of the main quarry building is a platform, or working floor, about 300 ft. long by 15 ft. wide, serving as a trimming yard and loading platform for finished stone. An air pipe line runs the full length of this platform, connecting with the receiver in the compressor room. At intervals along the yard small corrugated iron shops have been built, each completely equipped with a water tank, tool chest, tools, etc., and a complement of Haeseler pneumatic tools manufactured by the Ingersoll-Sergeant Co. Branch pipes from the main line furnished air to these tools. Fourteen of the hammers are in use, of different types and sizes, adapted to the various process of chipping, cutting, surfacing, dressing and carving.

Beside the quarry just described, development is being made of a deposit of very high grade "tepetate," which is being placed on the building material market. An extensive deposit of black sand of volcanic origin is also being opened up and placed on the market for use in concrete work. Another enterprise is the production of brick, terra cotta and roofing tiles. For this work an extensive system of ovens is being installed, each chamber to have a capacity of 20,000 pieces.

## THE ROOSEVELT MASONRY DAM, ON SALT RIVER, ARIZONA.

Bids for a high masonry dam on Salt River, about 70 miles east of Phoenix, Ariz., are to be received until Feb. 8, 1905, by the U. S. Reclamation Service, at Phoenix, Ariz. This dam has been named in honor of President Roosevelt, but the reservoir of 1,000,000-acre-feet (320,000,000,000 gallons) capacity which it is to form, will be named the Salt River Reservoir. The maximum height of the dam from the parapet of the roadway to the lowest assumed point of the foundation will be about 270 ft., or nearly as great as the corresponding height of the new Croton Dam. The spillway will be 210 ft. above mean low water in the river. The length of the dam at the spillway level will be 780 ft., and at mean low water, 210 ft. About 300,000 cu. yds. of cyclopean rubble masonry will be required for the dam.

The general location of the dam and reservoir is shown by Fig. 1. A plan and a cross-section of the dam are shown by Figs. 2 and 3.

Mr. F. H. Newell, M. Am. Soc. C. E., is Chief Engineer of the Reclamation Service, which falls under the U. S. Geological Survey, Department of the Interior. The dam has been designed under the direction of a board of engineers by Mr. F. Teighman, with Mr. Louis C. Hill as Supervising Engineer.

In the construction of the dam eight hours will constitute a day's work, no Mongolian labor and no foreign laborers imported under contract will be allowed. Bidders should allow for the fact that certain railways have agreed to make concessions in rates for the benefit of the United States in favor of this work.

Provisions as to sanitation and the sale of liquor are as follows:

SANITATION.—The chief engineer may establish rules for sanitary and police regulations for all forces employed under this contract; and should the contractor fail to enforce these rules, the engineer may enforce them and

...s against the contractor the cost thereof, which will be ...educted from any sum due on the contract.

...D OF LIQUOR.—The use and sale of intoxicating li... will be absolutely prohibited on the work except un... the direction and supervision of the engineer or his ag..., and then only for medicinal purposes.

...ther portions of the specification of most gen... interest are given in full as follows:

...JECT OF THE WORK.—The object of the work is t... construction of a masonry dam in the canyon of the S... River below the mouth of Tonto Creek, Ariz., for the p...ose of impounding about 1,000,000 acre-feet of water.

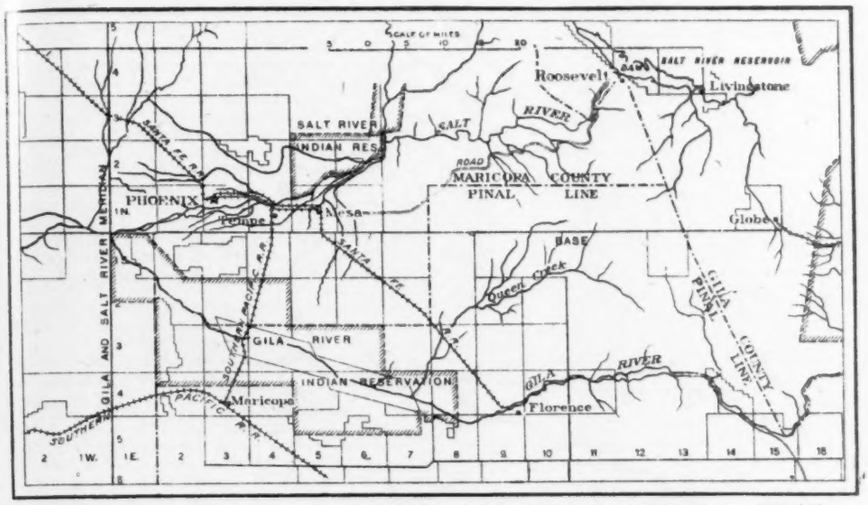



FIG. 1. MAP SHOWING LOCATION OF ROOSEVELT DAM AND SALT RIVER RESERVOIR, ARIZONA.

Two spillways, each about 200 ft. long, carry the flood waters around the dam. A roadway is carried across the dam, crossing the spillways on concrete-steel bridges. The general dimensions of the dam are as follows:

| | Feet. |
|---|---|
| Height of spillway above datum or mean low water. | 210 |
| Height of roadway above datum or mean low water. | 230 |
| Lowest point of foundation below datum..... | 36 |
| Length of dam at datum..... | 210 |
| Length of dam at spillway..... | 780 |

DIVERSION.—Floods exceeding 4,000 sec.-ft. are liable to go over the dam. The river, at low stage, shall be diverted through the tunnel or temporary flume by means of a temporary diversion dam not less than 12 ft. high above the bottom of the tunnel, and made as tight as practicable with sheet-piling securely connected with the dam. The stream shall be conducted well below the vicinity of the dam before discharging into the river. A row of sheet-piling shall also be driven across the canyon below the dam site to prevent the return of water by seepage. As soon as practicable a tight wooden flume, not less than 50 ft. wide and 5 ft. deep, shall be provided, leading from a level 5 ft. below the top of the diversion dam and discharging below outlet of tunnel. The construction of dams, cofferdams, flumes, and all other diversion and protection works shall be done at the contractor's cost without extra compensation. The necessary lumber for such works will be furnished, after due notice, by the United States at the dam site at the rate of $25 per M. ft. B. M., the charge therefor to be deducted in the monthly statements of amounts due the contractor. No sawed lumber over 22 ft. in length can be furnished.

EXCAVATION.—All material will be measured in place, and the material excavated from the foundation shall be paid for in three classes:

(1) Loose material consisting of sand, gravel and bowlders of less than 10 cu. ft., and all other material which may occur excepting solid rock in place.

(2) Solid rock in place, lying below the datum, which is about low-water surface, and bowlders of 10 cu. ft. or larger.

(3) Solid rock in place above datum.

FOUNDATION.—The foundation shall be thoroughly cleaned of all gravel, sand and earth, and all fissured or disintegrated rock shall be removed so that the dam shall be founded on solid rock throughout, and in such manner as required by the engineer in charge. Explosives shall not be used in excavating the rock in the foundation unless absolutely necessary, and when used, shall be in small quantities only, and in a manner approved by the engineer. A trench shall be cut in the solid rock of the foundation 15 ft. from the heel of the dam, and parallel thereto, and shall be 10 ft. wide and 6 ft. deep below the bottom of the dam on the line of the trench.

REMOVAL OF TEMPORARY WORKS.—All cofferdams or other temporary works shall be removed by the contractor, free of cost, at such times as the engineer may direct.

SIDE WALLS.—Above the bed of the river the side walls shall be cut away until they present surfaces normal to the face of the dam suitable, in the judgment of the engineer, for solid and safe junction with the masonry. This shall be paid for by the cubic yard as solid rock at the price agreed upon in the contract; any earth or loose material occurring in the side walls will be small in amount and shall be removed by the contractor without extra charge.

OVERHAUL.—All material excavated from the foundations and side walls shall be placed where directed by the engineer. Whenever the engineer may require any material transported more than 300 ft. from the point of excavation the distance over 300 ft. will be paid for as overhaul at the price agreed upon in the contract.

MASONRY.—The main body of the dam shall be constructed of broken range cyclopean rubble, laid so as to break joints and thoroughly bond the work in all directions. The stone shall be quarried from the walls on each side of the canyon shown in the drawing as proposed spillways. If a sufficient quantity of hard fine-grained stone cannot be obtained in these spillways it shall be quarried from the bluffs at either end of the dam at locations designated by the engineer, at the contractor's expense. Each stone shall be thoroughly drenched and cleaned of dirt and laid in Portland cement mortar of the quality hereafter specified. Vertical joints between the stones inside of the face stone of the dam must be nowhere less than 6 ins., and must be thoroughly filled with Portland cement concrete, or mortar, which should be rammed into place by hand, to the end that all space in the dam not occupied by stone shall be absolutely filled with mortar. Spalls may be rammed into the mortar in the vertical joints and rock may be rammed into the concrete where the joints are large enough. No rock shall come nearer to another than 2 ins. All overhanging edges shall be hammered off, and concave or otherwise improper beds are prohibited. The aim shall be to use the largest proportion of stone and the smallest proportion of mortar and concrete in the dam that can be practically secured. To this end facilities shall be provided for handling stones weighing 10 tons, and large stones shall be used as far as practicable.

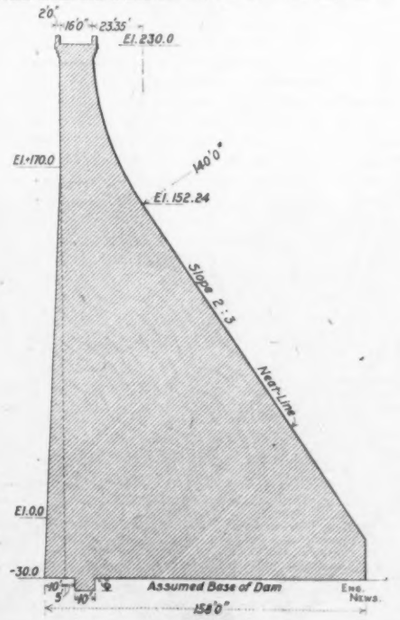



Fig. 3. Maximum Cross-Section of Roosevelt Dam, Salt River, Ariz.

WATER PIPES.—The contractor shall provide water pipes on the work, by which at any time any portion of the masonry may be thoroughly wet, and these shall be used whenever required by the engineer. All masonry shall be kept wet during the time of construction and until the work is at least six days old.

UPSTREAM FACE.—The stone for the upstream face shall be selected so as to lie with horizontal beds and vertical joints in Portland cement mortar, composed of 1 part cement to 2 parts sand. No mortar joint in the face shall exceed 2 ins. in thickness. At least one-third of the area in the face must be headers evenly distributed throughout the wall, and every header shall be laid over a stretcher of the underlying course. The stone shall be so arranged as to break joint in no case less than 1 ft. with the stone of the underlying course. The stretchers must be not less than 3 ft. long nor less than 2 ft. in any other dimension; the headers must not be less than 6 ft. in length nor less than 2 ft. in any other dimension. The joints in this face of the dam shall be dug out to a depth of at least 3 ins. and at such times as directed shall be carefully pointed by hand with mortar composed of equal parts of sand and cement, or with such material as shall be required by the engineer and furnished by the United States, and this shall be done as thoroughly as possible in order to make a water-tight surface. Immediately before pointing, the joints shall be thoroughly washed out with a hose. Projections of 12 ins. or less beyond the lines of the drawings will be permitted where they are of such symmetry as not to be unsightly. The face wall shall be kept at all times at least one course higher than the body of the dam opposite.

DOWNSTREAM FACE.—The stone for the downstream face shall be so selected as to lie with horizontal beds and vertical joints, and each stone shall be laid in a bed of cement mortar composed of sand and cement in the proportion directed by the engineer; where not otherwise directed the proportions shall be 1 part of cement to 2½ parts of sand. At least one-fourth of the area in the face must be headers evenly distributed throughout the wall, and every header shall be laid over a stretcher of the underlying course. The stone shall be laid in steps and shall have a proper bond with the stone of the underlying course. Projections of 2 ft. or less beyond the lines of the drawing will be permitted where they are of such symmetry as not to be unsightly. Payments will be made in every case for material within the neat lines of the drawing only. The face wall shall be kept at all times at least one course higher than the body of the dam opposite.

CONCRETE.—All concrete used in the dam shall be composed of Portland cement, sand and broken stone, in the proportion by volume directed by the engineer. The run of crusher will be taken, the parts passing a ¼-in. screen being classed as sand. The sand shall be free from organic matter, and contain not more than 10% of clay or other foreign mineral substance. Where not otherwise directed, the proportions of separate aggregates shall be 1 part of cement, 2½ parts sand, and 4 parts of broken stone of such size as to pass through a 2-in. mesh screen.

SAND.—The contractor shall provide screens for ascertaining the proportion of materials of various sizes produced by the crusher, in order to enable the engineer to determine the necessary proportion of sand in the concrete; and he shall at intervals, when required, make such tests as may be necessary for this purpose without extra charge. Sand required in addition to the run of the crusher, or such substitute as the engineer may adopt, will be furnished by the United States at the dam site, without cost to the contractor.

MIXING.—The mixing shall be done by a machine whenever practicable, and the style of machine shall be subject to approval by the engineer. Whenever the machine fails to perform the mixing thoroughly it must be made satisfactory or removed and another machine substituted. When from any cause resort to hand mixing is necessary, this shall be done thoroughly and to the satisfaction of the engineer.

WATER.—The water used for mixing must be free from organic matter. The amount of water used both in mixing and reasoning the concrete after it is placed in the work must be satisfactory to the engineer. All concrete will be used as wet as will give good results and as the nature of the work will permit.

CEMENT.—All cement will be furnished by the United States and will be delivered to the contractor near the cement mill in Tonto Basin.

TIME OF BEGINNING WORK.—Within twenty days after receipt of contract for signature the successful bidder shall execute the same and file a satisfactory bond. Within thirty days after notice of signature of contract by

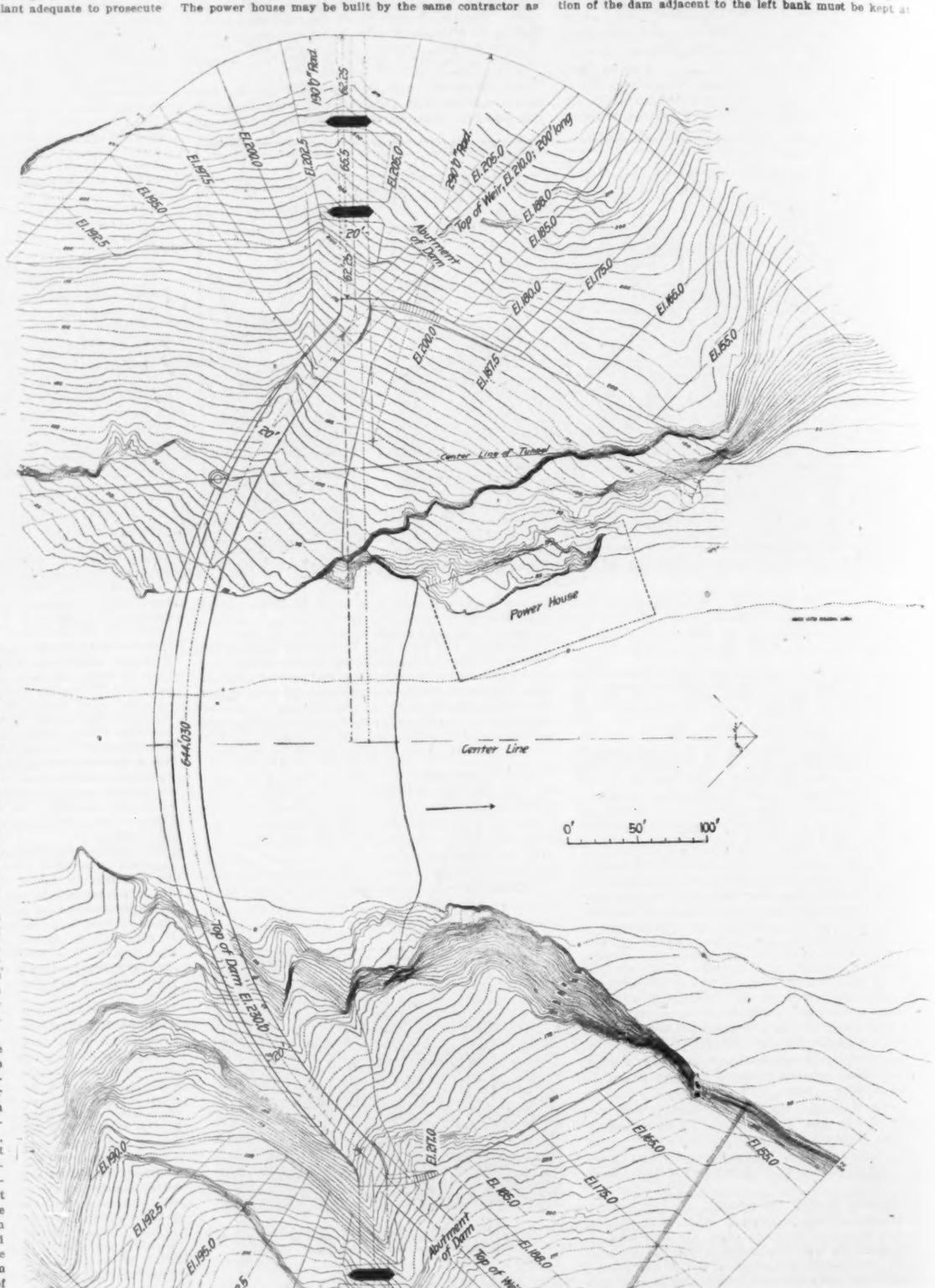
the Secretary of the Interior, the contractor shall begin work under the contract, and within ninety days thereafter shall have on the work as large a force as can be economically employed, and a plant adequate to prosecute the work in the most rapid and efficient manner practicable and carry it to completion as specified in the proposal. He shall employ three daily shifts of eight hours each on masonry construction, and shall provide an ample number of electric lights to efficiently illuminate all work in progress at night. The number of lamps and the type thereof shall be subject to the approval of the engineer.

DEFAULT.—Should the contractor fail to begin the work within the time allowed, or fail to begin the delivery of material as provided in the contract, or fail to prosecute the work or delivery in such manner as to insure a full compliance with the contract within the time limit, or default in any other manner in the proper execution of the work, all the machinery, tools, appliances, and animals employed on any of the works to be constructed under the contract, and all materials belonging to the contractor delivered on the ground shall be and become absolutely the property of the United States.

DEDUCTION FOR FAILURE TO COMPLETE.—Bidders will state in their proposals the time in which they propose to complete the dam to a height of 150 ft. above the datum, which datum is about low-water mark. Time is an element in the construction of this work and will be considered in the examination and comparison of bids and the award of the contract therefor. If the work is not completed within the time agreed upon in the contract there will be deducted from all payments made on said work after the expiration of said time the sum of $250 per day for every day occupied in excess of the time agreed upon in the contract, as liquidated damages for the loss to the Government on account of engineering superintendence, and the value of the operation of the irrigation works dependent thereon, said sum to be deducted from any amount due under the contract.

COMPLETION.—After the completion of the dam to the 150-ft. level, it shall be discretionary with the engineer whether masonry work on the dam be permitted during the months of June, July, August and September, but work shall be prosecuted vigorously and continuously during the remaining eight months of the year, at a rate per month of not less than two-thirds of that achieved during the construction of the lower portion, of the dam considered in cubic yards of masonry laid. The contractor shall place in the masonry such iron and steel in such manner as the engineer may direct. The metal will be furnished at the dam site by the United States. The United States reserves the right to vary the section of the dam above the 150-ft. level. The section shown on drawings is for comparison of bids only.

POWER PLANT.—The United States reserves the right to construct a power plant at or near the location shown in the drawings without hindrance from the contractor. The power house may be built by the same contractor as the one building the dam, by another contractor, or by the United States, as may best conserve the public interests. After the work on the power plant is begun, that portion of the dam adjacent to the left bank must be kept at



less 10 ft. higher than the rest of the dam, as a protection to the power house in case of overflow. The United States reserves the right to store and use the water in the reservoir up to a level 25 ft. below the lowest point of the top of the masonry.

POWER.—Electric energy for all lights for construction purposes will be furnished free of charge at the dam. Electric energy for all power purposes required by the contractor will be furnished at the dam, to be measured at the power plant and charged for at the rate of ½ ct. per HP. hr. up to a limit of 400 HP., and 1 ct. per HP. hr. for all power in excess of 400 HP., the charges therefor to be deducted in the monthly statements of amounts due the contractor. The United States does not guarantee the delivery of more than 600-HP.

REPAIRS.—Repairs required by the contractor will be performed when feasible in the repair shop attached to the cement mill, and will be charged at cost for necessary labor and material plus 15% for use of tools.

PAYMENT OF EMPLOYEES.—The contractor shall make such banking arrangements that his employees may not be subjected to loss in securing their wages.

PAYMENTS TO CONTRACTOR.—Payments will be made to the contractor as follows: At the end of each calendar month the engineer shall make an approximate measurement of all the work done up to that date, and an estimate of the value of the same at the prices agreed upon in the contract. A deduction of 20% shall be made from this estimated amount, and from the balance shall be deducted the amount of all previous payments. The remainder shall be paid to the contractor upon the presentation of proper accounts. The 20% so deducted shall be retained by the Government until the work shall have been completed to the entire satisfaction of the chief engineer and the Secretary of the Interior, and then be payable to the contractor, his heirs, assigns, or legal representatives; provided, however, that in the event of default on the part of the contractor all of the moneys retained under this paragraph in the hands of the Government shall be and become absolutely the property of the United States in reimbursement of any damage which may result through the failure of the contractor to fully and satisfactorily comply with the terms and conditions of his contract. After 50% of the work shall have been completed the foregoing deduction of 20% shall no longer be made, but the contractor shall be paid the full value of the work done during each month. The balance due upon completion of the work shall be paid as provided in paragraph 36.

## THE AMERICAN FOREST CONGRESS AT WASHINGTON, D. C.

The growing interest in forest preservation in America was made evident last week at Washington when over 80 delegates and a large number of guests met to discuss ways and means at the American Forest Congress. The meeting was held under the auspices of the American Forestry Association and lasted five days, one of which, however, was taken up with the routine work of registering the delegates and by their reception in a body by President Roosevelt. The actual business sessions were eight in number, each being devoted to the consideration of a single topic. Thus, the relations of the forests to irrigation, lumbering, grazing, the railways, mining and the general public were each discussed by several speakers in formal papers. Altogether some fifty papers were read and discussed and there were in addition a number of informal addresses by prominent members of Congress, foreign diplomats, cabinet officials, and men prominent in national affairs.

ORGANIZATION.—The first session of the Congress on Tuesday morning, Jan. 3, was devoted to the organization of the delegates for business. Hon. James Wilson, Secretary of Agriculture, welcomed the Congress and outlined the necessity and significance of forest preservation in the United States in an interesting address. His remarks were in part as follows:

> Forestry and irrigation go hand in hand in the agricultural development of the West. The West must have water, and that in a sure and permanent supply. Unless the forests at the headwaters of the streams used in irrigation are protected, that is impossible, and irrigation will fail. Unless we practice forestry in the mountain forests of the West, the expenditure under the national irrigation law will be fruitless, and the wise policy of the government in the agricultural development of the arid regions will utterly fail. Without forestry, national irrigation will be merely a national mistake.
>
> In the value of its invested capital and its product, lumbering ranks fourth among our great industries. But in its relation to the forest it stands first. The vast area of the timber lands of the United States is mainly in hands of the lumbermen. You have it in your power, by putting forestry into effect upon the lands you own and control, to make the lumber industry permanent; and you will lose nothing by it.

The regulation of grazing upon the public forest lands is a forest question, and, like all other national forest questions, its settlement always should be for the best interests of the people most deeply interested. The principles which control the conservative use of the public ranges are identical with those which control the conservative use of the public forests. The objects are a constant supply of wood and water on the one hand and of forage on the other. Just as the sawmills eventually shut down unless forestry is applied to the forest from which the sawlogs come, so the horses, the cattle, and the sheep of the West must decrease both in quality and number, unless the range lands of the arid region are wisely used. Overgrazing is just as fatal to the live-stock industry as destructive logging is to the lumber industry. The highest returns from the forest can be had only through recognizing it as invested capital, capable under wise management of a steady and increasing yield, and the permanent carrying power of the range can be maintained or increased only by the wise regulation of grazing.

The relation of railroads to the forest is no less vital than that of the lumbermen. The development of systems of transportation upon a secure basis depends directly upon the preservation and wise use of the forest. Without a permanent supply of wood and water the business of the railroads will decline, because those industries upon whose production that business mainly depends cannot prosper.

The importance of the public forest lands to mining is direct and intimate. Mines cannot be developed without wood any more than arid lands can become productive without water. The public forest lands are, and must continue to be, the chief source of timbers used in our Western mines. I am particularly glad that this Congress will include a full discussion of national and State forest policy. The forest movement in several States has already resulted in the adoption of definite State forest policies. In many others the time is ripe for useful work, because of the existence of a strong sentiment for the best use of the forest. The forest problems in different States cannot all be solved in exactly the same way. The methods in each case will have to be worked out on the ground where they will be used. But we have before us here the same opportunity in State forest matters as in other phases of the forest problem, for full discussion of methods and results. Above all, we must find the most effective means of working together toward the same great ends.

The report of the Board of Directors of the American Forestry Association was read, showing a total membership of 2,199. The forest reserves of the United States now number 61 and embrace a total area of 63,348,656 acres. This is an increase of 585,162 acres since June 30, 1903.

The reading of this report was followed by informal addresses by Dr. Andrew White, Commissioner of Crown Lands of Canada; Dr. Edward Everett Hale, Prof. Filbert Roth, University of Michigan; Dr. C. A. Schenk, Forester, Biltmore Estate, North Carolina, and Representatives Lacy of Iowa and Reeder of Kansas.

IRRIGATION.—The session devoted to consideration of the relation of forest preservation to irrigation was presided over by Senator Clark of Wyoming. The first paper to be read was by Mr. G. E. Mitchell, Secretary National Irrigation Association, on "The Close Relation Between Forestry and Irrigation." The author pointed out the rôle played by forests in the conservation of the rain and snow waters and urged that steps be taken to preserve the present forests before their destruction necessitated the much more expensive resort of reforestation. Mr. F. H. Newell, Chief Engineer, U. S. Reclamation Service, followed with a paper on "Forests and Reservoirs," in which he outlined briefly the work that had been done by that bureau to protect the headwaters of great streams. A paper by Mr. J. B. Lippencott, U. S. Geological Survey, on "The Importance of the Forest Reserves in Connection with Irrigation Projects," discussed chiefly the manner in which forests acted to conserve the rainfall. He said in part:

> The relation of rainfall to run-off is very uncertain, depending upon the nature of the storms, whether gentle showers or violent rains, the steepness of the drainage basin and its covering, and whether the precipitation is snow or rain. It has been found that in the districts where the forest cover is small the output of the basin occurs in violent floods of short duration. Because these floods are violent, and of large volume, and owing to the fact that the soil of the drainage basins is not held together by a network of roots, extensive erosions occur in these barren basins, and the stream carries much silt in suspension. Where the basin is covered with forest, the mat of twigs and leaves which covers the ground is an absorbent sponge, retaining in itself large quantities of water and preventing evaporation from the underlying soil. This permits of a holding back of the floods and the gradual draining off of the water, thus largely accomplishing the purpose of regulating reservoirs.

The succeeding papers were by Mr. A. P. Davis, Assistant Chief Engineer Reclamation Service on "Irrigation Construction and Timber Supplies," and by Mr. Morris Bein, Engineer Reclamation Service on "Rights of Way in Forest Preserves."

TIMBERING.—The third session of the Congress was given up to topics on the relation of forest preservation to the lumber industry, and was most notable in showing the extent to which leading lumbermen are alive to the necessity of taking vigorous measures to prevent wasteful lumbering operations. A number of the speakers urged more vigorous laws controlling the cutting of timber. The general tenor of the remarks is well exemplified by the following excerpt from the address of the chairman, Mr. N. W. McLeod, President National Lumber Manufacturers' Association:

> Lumbermen who have studied the timber situation realize that in the future, as in the past, the largest returns are not to be obtained from their manufacturing plants. The largest fortunes that have been made in the business have been acquired by the owners of large bodies of timber lands. For the purpose of illustration—consider the supply of timber as represented by a circle, the annual consumption as another circle—that of consumption is annually increasing, caused not only by the natural increase in population, but by a material increase in per capita consumption; on the other hand, the circle of supply is annually decreasing, and unless the forests are reserved for use, instead of being sacrificed to immediate low cost of production, the circle of supply, as far as it can be considered a commercial factor, must disappear. If this be true, all government timber-lands should be withdrawn from sale or entry and placed under forestry supervision, all mature growths being subject to sale, providing proper protection for the young timber, and thus perpetuating, at least, a partial supply for future generations by protecting the timber from destruction by fire, disease, and waste, reserving the increment for use.

GRAZING.—The session devoted to the relations between the grazing interests and forest preservation called out only three papers as four of the speakers on the programme had failed to put in appearance. The papers that were read were general in character and received little discussion. Col. W. S. Harvey, of Pennsylvania, urged that the influence of the American Forestry Association be exerted toward inducing Congress to set aside 3,000,000 odd acres of land in the Appalachian range as a forest reserve, which was now being asked by the various commercial bodies of that region.

RAILROADS.—The session devoted to the consideration of the railways in relation to the forests brought out three papers of considerable interest besides several impromptu addresses from railway men and foresters. In a paper on the "Work of the Pennsylvania R. R. in Planting Timber for Cross-ties," Mr. J. T. Richards, Chief Engineer, Maintenance of Way, gave figures showing the consumption of timber for cross-ties and stated that the Pennsylvania R. R. had made a beginning toward tree plantations for supplying some at least of the ties actually consumed each year in new track and removals. The land being used for plantations was right of way from which the railway had been removed because of changes in route as time had passed, and the timber being planted was yellow locust. Generally the trees were being planted about 10 ft. apart, or about 400 per acre. So far 223,556 trees had been put into the ground and it was planned to plant fully 800,000 trees next season. This paper was followed by one by Mr. L. E. Johnson, President, Norfolk & Western Ry., entitled "Is it Practicable for Railroads to Hold Forest Lands for Future Supplies of Timber?" Assuming a mileage of road, local conditions of timber supply and land values as represented by the Norfolk & Western Ry., and assuming twenty years as the period at which the first planting could be cut for ties, Mr. Johnson presented a detailed estimate of the cost to the railway of raising and cutting its own ties as compared with the cost of purchasing them. The figures showed that railway tie plantations would be highly economical. Despite this, the author pointed out, it was not practicable for railways to have such plantations because of the impossibility in many sections of the country of securing the tremendous areas of land that would be required. Mr. Johnson was followed by Dr. Hermann Von Schrenk of the U. S. Bureau of Forestry with a paper on "Results in the Preservative Treatment of Railroad Timbers to Prolong Durability." The author quoted results of experience with preservative processes for timber and referred to the recent experiments made by the Bureau of Forestry on the strength of treated timbers. A brief account of these experiments, reprinted from a circular distributed at the Congress, is given in another column.

MINING.—The papers presented at the session devoted to the mining interests were too general in character to be of special interest to engineers; their scope is indicated by the following titles: "The Development of Water-Power as Related to

Forest Reserves," by A. L. Fellows, Consulting Engineer, Reclamation Service; "Importance of Timber Supply in Mine Development in the West," by Prof. J. A. Holmes, State Geologist of North Carolina; "How the Forest Reserves Help Mining," by T. J. Grier, Superintendent Homestake Mining Co., South Dakota; "Mining in the Forest Reserves," by F. A. Fenn, Supervisor Forest Reserves in Idaho and Montana.

GENERAL QUESTIONS.—Two sessions were given up to general questions of forest reservation and national and State forest policies. At the afternoon session of Jan. 5 the Congress was addressed by President Roosevelt and by Mr. J. J. Jusserand, Embassador from France. Papers were also read by President Howard Elliott, Northern Pacific Ry.; Hon. John Lamb, Member of Congress from Virginia, and others. At the closing session on Jan. 6 the following list of papers were read and discussed: "Work of the Bureau of Forestry," by Overton W. Price, Associate Forester, Bureau of Forestry. "Work of the Geological Survey in Mapping the Reserves," by Charles D. Walcott, Director, U. S. Geological Survey; "Work of the General Land Office in the Administration of the Reserves," by W. A. Richards, Commissioner, General Land Office; "A Federal Forest Service," by Gifford Pinchot, Forester, U. S. Department of Agriculture; "Progress in Forest Reservation in Pennsylvania," by Dr. J. T. Rothrock, of the Pennsylvania Reservation Commission; "The Value of Forestry to Commercial Interests," by Geo. H. Maxwell, Executive Chairman, The National Irrigation Association.

## A REAMING DRIFT PIN FOR BRIDGE ERECTION.

By F. T. Darrow.*

The drawing and photograph presented on this page illustrate a successful steel drift pin in use for reaming rivet-holes during the riveting of steel bridges erected on the C., B. & Q. R. R. lines west of the Missouri River. The coil or turning

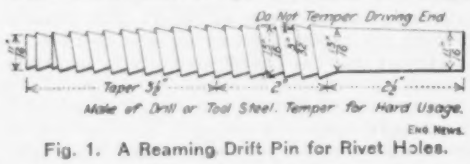



Fig. 1. A Reaming Drift Pin for Rivet Holes.

shown in the photograph was made by this drift-pin, during the riveting of a Pratt span at Washington, Kansas. It was necessary to ream out some 11-16-in. holes to 15-16-in. for ⅞-in. rivets. The drift was tried and was successfully driven through the plates with an 8-lb. hammer, making a good hole. The threads of the pin were completely filled with metal cut from the plates and the coil or shaving shown is a part of this metal

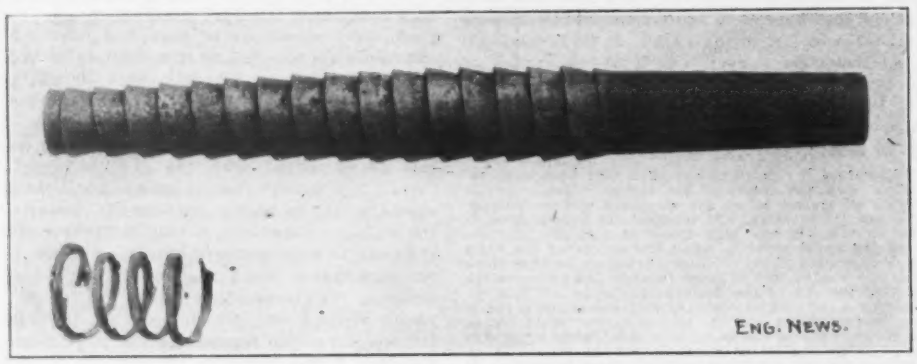



FIG. 2. PERSPECTIVE VIEW OF REAMING DRIFT PIN AND CHIP CUT BY IT.

which was taken out of the threads and sent in as a sample. The pin suffered but little by this treatment and the plates were not bent or torn in the least. This was a very severe and unusual test as ⅛-in. of metal all around the pin was removed. The saving over using hand-ratchet and reamer is obvious.

This drift pin has been tried at many other places and gives perfect satisfaction. It is used only during riveting and fairs the holes without injury to the plates. It is much preferred to fluted reamers by the men, as it makes straighter holes with less work and in less time. It does not give the swaging or thickening effect on the plates which the usual barrel drift gives, as it cuts the projecting edges away instead of staving them back, thus giving smoother holes and tighter plates.

These drifts are made of good drill or tool steel and tempered for hard usage. The driving end is not tempered.

*Division Engineer, C., B. & Q. R. R., Lincoln, Neb.

## DISTRIBUTION OF VELOCITY IN STREAM FLOW.

By John C. Hoyt,* Assoc. M. Am. Soc. C. E.

In developing methods for the measurement of the flow of streams by the current meter considerable study has been given to determining the proper depth or depths at which to hold the instrument. The basis for these studies has been the making of vertical velocity curves, which consisted in measuring a sufficient number of velocities in a vertical to develop a curve which will show the change in velocity from the surface to the bed of the stream. From this curve the mean velocity for the vertical is determined; also coefficients for reducing the velocities at any depth to the mean velocity, and the depth at which the thread of mean velocity is located.

The accompanying table gives the results obtained from 910 vertical velocity curves made at 39 different gaging stations by the hydrographers of the U. S. Geological Survey, and others. The beds at these measuring stations varied from rough rocky sections through all grades to smooth sandy beds. The depths ranged from 1.1 ft. to 36 ft., and velocities from 0.18 to 9.7 ft. per sec. Notwithstanding these varying conditions the coefficients agree very closely, which goes to show that the distribution of velocity follows definite laws which are practically true for all conditions of bed, stage, or velocity.

Results of Vertical Velocity Measurements of Streams.

| River. | Locality. | Number measurements. | Range of depth, ft. | Range of velocities, ft. per sec. | Depth of thread of mean velocity in % total depths. | Coefficient for reducing to mean velocity.—Six-tenths depth. | Top and bottom. | Top. |
|---|---|---|---|---|---|---|---|---|
| Susquehanna | McCalls Ferry, Pa. | 73 | 3.3—30.0 | 1.21—5.80 | 68 | .94 | 1.07 | 0.92 |
| " | " " " | 68 | 5.0—36.0 | 1.40—9.70 | 73 | .97 | .... | 0.96 |
| " | Harrisburg, " | 20 | 3.2— 8.0 | 1.52—2.71 | 61 | 1.01 | 1.08 | 0.85 |
| " | Binghamton, N. Y. | 36 | 2.5— 8.1 | .80—4.86 | 61 | .99 | 0.96 | .... |
| Chenango | " " | 34 | 1.7— 7.4 | .46—3.38 | 62 | .98 | 1.04 | .... |
| Catskill Creek | South Cairo, " | 47 | 2.1— 7.0 | .27—3.91 | 58 | 1.02 | .... | 0.89 |
| Delaware (E. Br.) | Hancock, " | 6 | 2.1— 4.8 | .75—4.12 | 59 | 1.02 | .... | 0.87 |
| " (W. Br.) | " " | 12 | 1.7— 4.2 | 1.67—4.45 | 58 | 1.02 | .... | 0.87 |
| Esopus Creek | Kingston, " | 53 | 1.9—14.0 | .65—5.04 | 62 | 1.00 | .... | 0.89 |
| " " | Olivebridge, " | 68 | 0.9— 5.2 | .42—7.62 | 58 | 1.01 | .... | 0.87 |
| Fishkill Creek | Glenham, " | 22 | 2.1— 5.0 | .26—1.75 | 59 | 1.04 | .... | 0.77 |
| Housatonic | Gaylordsville, Conn. | 36 | 2.1— 6.2 | .67—3.66 | 58 | 1.01 | .... | 0.87 |
| Rondout Creek | Rosendale, N. Y. | 21 | 4.4— 8.2 | .35—2.55 | 61 | .99 | .... | 0.89 |
| Schoharie Creek | Prattsville, " | 11 | 1.1— 6.6 | .52—3.20 | 58 | 1.01 | .... | 0.87 |
| Tenmile | Dover Plains, " | 33 | 1.8— 7.3 | .24—2.15 | 61 | .99 | .... | 0.87 |
| Wallkill | New Paltz, " | 52 | 3.3—17.3 | .18—4.72 | 64 | .98 | .... | 0.87 |
| Wappinger Creek | Wappinger Falls, " | 17 | 2.5— 4.7 | .58—2.11 | 58 | 1.03 | .... | 0.77 |
| Appomattox | Mattoax, Va. | 8 | 2.5— 4.9 | .92—2.30 | 62 | 1.00 | 1.11 | 0.81 |
| James | Cartersville, " | 6 | 3.0— 4.4 | 1.88—2.37 | 60 | 1.01 | 1.08 | 0.88 |
| Roanoke | Roanoke, " | 8 | 1.8— 3.3 | .87—1.96 | 61 | .99 | 1.01 | 0.81 |
| Staunton | Randolph, " | 20 | 2.0— 6.0 | 1.35—3.11 | 66 | .96 | 1.12 | 0.93 |
| Dan | Madison, N. C. | 42 | 1.3— 3.8 | .73—3.00 | 62 | .99 | 1.01 | 0.89 |
| " | So. Boston, Va. | 13 | 3.5— 9.0 | .90—2.41 | 64 | .98 | 1.09 | 0.90 |
| Reddie | N. Wilkesboro, N. C. | 3 | 1.7— 2.5 | 1.62—2.01 | 58 | 1.02 | .97 | 0.83 |
| Yadkin | " " | 33 | 2.7— 6.4 | 1.20—3.16 | 66 | .96 | 1.12 | 0.93 |
| " | Salisbury, " | 10 | 3.1—11.3 | .96—3.23 | 59 | 1.02 | 1.06 | 0.81 |
| Catawba | Morgantown, " | 39 | 1.9— 5.0 | .74—2.84 | 61 | 1.00 | 1.04 | 0.82 |
| " | Mount Holly, " | 2 | 6.3— 7.0 | .49— .74 | 58 | 1.00 | 1.08 | 0.88 |
| " | Belmont, " | 1 | 3.5 | 1.54 | 59 | 1.01 | 1.05 | 0.80 |
| Wateree | Camden, S. C. | 4 | 12.3—17.7 | 1.33—1.83 | 58 | 1.01 | 1.13 | 0.90 |
| Broad | Alston, " | 4 | 5.0— 8.9 | 2.79—4.00 | 65 | .96 | 1.22 | 0.89 |
| Saluda | Waterloo, " | 3 | 3.0— 8.5 | 1.76—2.01 | 62 | .97 | 1.03 | 0.82 |
| Watauga | Elizabethton, Tenn. | 10 | 2.6— 5.3 | .34—1.01 | 61 | .98 | 1.07 | 0.82 |
| S. Fk. Holston | Bluff City, " | 13 | 1.9— 4.1 | 1.08—6.77 | 62 | 1.02 | 1.05 | 0.80 |
| Nolichucky | Greeneville, " | 22 | 1.6— 5.1 | .49—2.69 | 59 | 1.02 | 1.02 | 0.80 |
| French Broad | Oldtown, " | 9 | 4.2— 8.0 | .53—2.18 | 62 | .99 | 1.07 | 0.86 |
| Pigeon | Newport, " | 4 | 4.4—11.6 | .82—1.14 | 61 | .99 | 1.15 | 0.91 |
| Tuckasegee | Bryson City, N. C. | 36 | 3.5— 8.5 | .50—3.39 | 64 | .97 | 1.09 | 0.98 |
| Little Tennessee | Judson, " | 11 | 2.7— 6.0 | 3.84—7.45 | 59 | 1.03 | 1.06 | 0.83 |
| | Total | 910 | ..... | ..... | ... | ..... | ..... | ..... |
| | Range | .... | 1.1 to 36.0 | .18 to 9.70 | 58 to 73 | .94 to 1.04 | .96 to 1.22 | .78 to .95 |
| | Mean | .... | ..... | ..... | 61 | 1.00 | 1.07 | .85 |

A study of the table shows the depth of the thread of mean velocity to be between 58 and 73% of the depth of the stream, the mean being 61% of the depth.

In the greater part of the stream gaging done by the U. S. Geological Survey the thread of mean velocity is assumed to be at six-tenths depth. The observations show the errors due to this method to arrange from — 6% to + 4%, with a mean of 0%, thus showing that the six-tenths depth method gives results well within the degree of accuracy which can be expected for work of this kind.

When the velocity is determined at the top (usually from 0.5 to 1.0 ft. below the surface), which method is used largely for flood measurements, the coefficient for reducing to mean velocity varies from 78 to 95%, with a mean of 85%. For the greater depths the coefficient is largest and 90% is usually used for flood stages.

The top and bottom method gives results too small, owing to the fact that the velocities measured near the bottom are especially low, on account of the roughness of the bed. The coefficient for reducing to mean velocity in this case varies from 96 to 122%, with a mean of 107%.

*U. S. Geological Survey, Washington, D. C.

A CHICAGO RIVER LIGHTERAGE SERVICE has been instituted as a means of improving the freight transportation facilities of the city. A freight station has been opened at Grand Ave. and Erie St. and other stations will be established where freight can be received, delivered and distributed as desired, and where freight can be received from and for all railways having water facilities. Instead of different wagons having to be sent with freight to the different railways, a wagon can deliver a miscellaneous load at one of the river stations where it will be sorted and distributed. It is expected that this will materially reduce the amount of teaming required by individual firms. The river service is maintained by steam barges or lighters and the system is entirely independent of any railway or steamboat line. It is operated by the Chicago Car Ferry & Lighterage Co., of which Mr. J. G. Johnson is President and Mr. E. H. Talbot, Vice-President and Manager.

# ENGINEERING NEWS

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The National Forest Congress, held last week at Washington, D. C., as noted elsewhere in this issue, deserves mention for several good reasons. It is a notable fact, in the first place, that over 800 delegates, coming from all sections of the country, should gather to discuss ways and means of forest preservation. It is still more notable that a large proportion of these delegates should be men who actually use the forests. There were present prominent lumbermen, railway officers of high rank, owners and managers of mines, cattlemen, and farmers concerned in the development of the irrigable west. The significance of this representation cannot be overlooked. It means that the impulse for the conservative use of the forest is beginning to come from within, from the men who are actively interested in the use of the forest, and not from without, from those whose interest is mainly philanthropic and general. This change from past conditions means, to a large extent, the difference between mere agitation and actual execution, between the hope of accomplishment and the thing done. No one who attended the sessions of the Congress could fail to note the earnest interest manifested by the delegates in their work. This interest was even more pronounced among those who represented the agricultural and industrial interests concerned in the use of the forests than it was among the professional foresters of the state and national reservation bureaus. Indeed, some of the severest castigations of the "land pirate" and "lumber skinner," and of the destructive cattleman, were delivered by lumbermen and cattle-raisers. With this spirit among the actual owners and users of the forest, there is certainly much hope that the future will witness a decided change from the wanton destruction and wasteful use of our forest wealth that have darkened the record of the past.

The need of a census of population oftener than once in ten years is frequently felt by engineers and municipal officials. A way in which this want may be at least partially met is stated by Mr. S. N. D. North, Director of the U. S. Bureau of the Census, in his report for 1903-4. It appears that in 24 of our states and territories, having an aggregate population of 32,700,000 in 1900, or 43 per cent. of the total population of the country, there are constitutional or statutory requirements for a decennial census of population. Between 1890 and 1895 these requirements were observed in 13 states, containing 31.5 per cent. of the population of the United States.

A Congressional act of 1879 provided for cooperation between state and federal authorities in census taking, the federal government to pay about one-half the cost of quinquennial enumerations to such states as availed themselves of the provisions of the act. Several states filed copies of their schedules at Washington and received the compensation provided for, but no use was ever made of the statistics, because there was not, as now, a permanent Census Bureau to compile them. A reenactment of the statute mentioned would now make possible efficient cooperation between a number of states and the Census Bureau and would make generally available such quinquennial censuses as many hereafter be taken. The plan would doubtless stimulate a number of states to join with those already taking a quinquennial census.

That cooperation in census taking is practicable has been proved during the present year, when the Census Bureau and the Secretary of State for Michigan joined forces in taking a census of manufactures. Similar arrangements have been made for the Massachusetts census of manufactures for 1905, while in 13 other states arrangements have been made with labor or industrial bureaus for joint action in the collection of more or less extensive industrial statistics. We suggest to the large proportion of our readers who feel the need of more frequent population censuses that they appeal to their representatives in Congress and to their state and municipal authorities to push this good work forward.

A notable difference in conditions governing the design of sewage works in Great Britain as compared with America, and one that should be borne in mind when American engineers propose to adopt British methods of treatment to the needs of this country, is the small volume of sewage proper at many of the British sewage works. As an illustration we may draw upon an engineering report on proposed changes in the sewage works of Rishton, Lancashire, England, made by Mr. Charles J. Lomax. The statements were found in the London "Surveyor" for Nov. 25, 1904.

The population of Rishton was 7,031 in 1901. In his estimates Mr. Lomax allowed for a population of 10,000 and a dry weather sewage flow of 24 U. S. gallons per capita per day. In accordance with the regulations of the Local Government Board, the works are designed to give full treatment to three times the dry weather flow and a partial treatment to an additional three times the dry weather flow. But the six volumes of dry weather flow (one of sewage and five of storm water) amount to only 144 U. S. gallons a day, which is no more than the average daily water consumption of many American cities.

The total dry weather flow at Rishton is assumed at 240,000 U. S. gallons a day. The sewage is to be screened, passed to a circular tank of about 24,000 U. S. gallons capacity, thence to two septic tanks with a combined capacity of 336,000 U. S. gallons. This will give a total tank capacity of 360,000 U. S. gallons, or 36 hours dry weather flow. The septic tank effluent will go to six so-called bacteria beds, 56 ft. in diameter at the top and 6½ ft. deep, giving a total area of 1,641 sq. yds. or about one-third of an acre, and a total volume of 3,556 cu. yds. At three times the dry weather flow these beds will be worked at the rate of 440 U. S. gallons per sq. yd. per day, or more than 2,000,000 U. S. gallons per acre. The beds will be composed of clinker. The character of the storm water beds is not stated. The sewage going to them has no other treatment.

Water consumption in America is, as a rule, much lower in the small towns than in the cities of 50,000 or 100,000 population and upwards. Nevertheless, it is seldom that an American engineer would feel justified in figuring on as little as 72 U. S. gallons of sewage proper per capita, or as small a volume for full continuous treatment as is contemplated during periods of rainfall only, at Rishton. Most of the sewage works of this country are adjuncts of separate sewerage systems, but at times of considerable rainfall the volume of flow in many of our separate sewers is largely augmented by surface water which finds its way into sewers through perforated manhole covers and by ground water which leaks or infilters through joints in the sewer pipe.

Therefore even with the separate system our sewage works may be called upon to treat large extra volumes during wet periods, so it is not inconceivable that the actual volume reaching one of our works from a separate system may equal the six times the dry weather flow which must have treatment, some full and some partial, at British works.

In view of the facts cited, great care should be taken in using British quantitative data in the design of American sewage works.

## THE PANAMA CANAL ADMINISTRATION.

For weeks past the newspapers have been full of rumors concerning the administration of affairs at Panama. It has been repeatedly stated that Congress at its present session will abolish the Canal Commission, and on Jan. 4 a bill to effect this was introduced in the House of Representatives. It has been alleged that Chief Engineer Wallace is at loggerheads with the Commission. The Congressional Committee appears to have returned from Panama with a fully formed plan to put an end to the Commission and place the work directly in Mr. Wallace's charge.

A great deal of discussion is also going on in the newspapers over the proposal to make a sea-level instead of a lock canal at Panama; and the idea has even been put forward that the Chief Engineer and the Commission are at odds over the proper type of canal to build, the former favoring the sea-level plan and the Commission a canal with locks.

That many of these current newspaper rumors are entirely baseless, we fully believe. It is, for example, insinuated that Chief Engineer Wallace himself is at the bottom of the movement to abolish the Commission, with the idea of upbuilding his own position. We mention this rumor only for the purpose of expressing our entire and emphatic disbelief in it. Not a single fact in support of this rumor has anywhere been made public, and we find it wholly impossible to believe that Mr. Wallace could have been guilty of so flagrant a breach of professional ethics.

Mr. Wallace has been criticised for making public the information regarding the engineering plans which was printed in our issue of Dec. 22; but the fact appears to be that he was in no wise responsible for this. When the Congressional Committee visited Panama, they, very naturally, asked Mr. Wallace, as Chief Engineer of the work, to give them information as to the engineering investigations now in progress. He complied, of course, with the request; and Chairman Hepburn, after the Committee's return to the United States, gave to the newspapers the stenographic report of Mr. Wallace's statements. So far as appears from these facts, there is no ground for criticism of Mr. Wallace; nor in all that he was quoted as saying was there anything to indicate that he cast any reflection upon the Commission or its conduct of affairs. It is true, Mr. Wallace expressed a doubt as to the success of Civil Service methods in selecting employees for Panama; but the establishment of civil service rules on the Panama work was done by order of President Roosevelt, so even on that point no issue between Mr. Wallace and the Commission is apparent.

The engineering profession has no written code of ethics; but always and everywhere it is deemed unprofessional conduct for a man to undermine the reputation of the man next above him for the sake of securing his place. Mr. Wallace has received from his professional brethren the highest honors at their disposal. He is well known to be an earnest advocate of upholding the dignity and reputation of the engineering profession. It is wholly impossible, therefore, to suppose that he

could have committed any such breach of professional ethics as has been insinuated.

Nevertheless, as we stated above, the Congressional committee appears to have returned from Panama fully determined to abolish the Canal Commission: and the inquiry naturally arises why this should be done. It cannot be said that the current newspaper reports give any satisfactory answer to this question. It is said that the Commission is an unwieldy body; but that is absurd on its face. The Commission has much the same relation to the canal as the Board of Directors of a railway company does to that company's enterprise; and it is seldom that a Board of Directors is made up of fewer than seven men. A still closer parallel is found in the Commissions which have had charge of other great public works, such as the Chicago Drainage Canal or the New York Rapid Transit Ry. Almost invariably such bodies are made up of as many members as the Canal Commission and frequently of a much larger number.

Another Washington correspondent sent the following to the New York "Tribune" of Jan. 5:

> Opinion in Congress seems to be crystallizing with regard to the Panama Canal legislation which will be required at this session, and chief among the decisions reached is that the Panama Canal Commission, as now organized and conducted, is a failure. It is declared that the combination in a single body of civil, executive, diplomatic and engineering duties is impracticable, and provision for the separation of these powers is probable. The indications are that before the adjournment of the present Congress provision will be made for an engineering commission, to consist of three members, which will take the place of the present cumbersome organization. The engineering problems in connection with the construction of the canal and their execution will be confided to this commission. Authority will be conferred on the President to utilize in connection with this commission such talent in the engineer corps of the army as he may consider desirable, but it is not unlikely that Chief Engineer Wallace will be suggested as the proper head for this commission. In this way, it is argued, the preparation of engineering plans, the construction of the canal, the government of the canal zone and more or less supervision of relations with the Republic of Panama, all by a single body, will be avoided.

This, again, is the sort of explanation that does not explain. Why should there be any objection to the "combination in a single body of civil, executive, diplomatic and engineering duties?" As a matter of fact it is in the highest degree important to the efficient conduct of the work that the entire responsibility for it in all its phases be laid upon one single body. Experience over and over again has shown the dangers of dual control and the advantages of centralized control. No one considers the Board of Directors of a corporation a cumbersome body because it maintains an oversight of all the corporation's work, in all its varied aspects, and the Canal Commission was created to be a Board of Directors of the canal enterprise. It was created not actually to do the engineering work or the diplomatic work, or the legal work or the sanitary work or the work of local government; but actively to direct work in all these channels.

Failing thus any satisfactory information in the public prints as to the underlying motives for the proposed abolition of the canal commission, we have set on foot careful inquiries of our own.

We find as a result of these inquiries that the real motive for the movement to abolish the Commission appears to be a belief that the members of the Commission have not given to their work the time and attention that was expected from them. The Congressmen in charge of canal matters, and it is said the President as well, expected that the members of the Commission would devote substantially their entire time to the work and would spend at least the greater portion of the year on the Isthmus, and their salaries were fixed at $12,000 a year on that supposition. One member of the Commission has in fact given up all his private business, removed to Washington and is devoting himself entirely to the canal work. Another member, Col. Frank J. Hecker, recently resigned on the ground that he could not afford longer to leave his private business and give the time which proper service in the Commission demanded. Three other of the members of the Commission, on whom chief reliance was placed for the active prosecution of work, have continued their private business and retained official connection with other enterprises, to the detriment, it is claimed, of the Panama canal work.

Thus, when the Congressional Committee visited Panama, they found, we believe, none of the Commission there. All the information regarding the progress of the work, they had to obtain from Chief Engineer Wallace and his associates; and under these circumstances it was entirely natural for the members of the Committee to think that if the work could progress so well with the members of the Commission all absent attending to their own private business, it might continue to progress if these members were left to devote their entire time to that private business, and their $1,000 a month salary from the Government were cut off.

We set down these facts not to criticise the Commission, but to record the situation as we find it, wholly without prejudice. It is a matter of current news of much interest to the engineering profession, and we should be derelict to our duty were we to fail to make public so much at least as we can ascertain of the facts, holding ourselves open to correction if in any respect we give other than a fair and correct statement.

Again, while we hold no brief for the Commission, we deem it proper to say in justice to its members that very likely they have been unconscious of having in any way neglected their duties as members of that body. Their understanding of what was expected of them appears to have been entirely different from the understanding prevalent at Washington. They appear to have understood that they were no more obliged to devote their entire time to the work of the Commission than the members of the New York Rapid Transit Commission are to give up their private business on joining that body. Carrying out the parallel between the Commission and a Board of Directors: it is common enough for a man to serve as a director of a dozen or more different corporations and at the same time attend to more or less private business besides. Without going to that extent, it is evident that several members of the Canal Commission saw no reason why their duties as members of that body should prevent them serving in official capacities on other engineering enterprises and devoting to them a large proportion of their time and energy.

It would be maintained, doubtless, by the members of the Commission, that the work at Panama has gone on under direction of the executive heads which they have selected as well as it could if the Commission had been personally resident at Panama. They would say—what is undoubtedly true—that it was not the Commission's duty to perform the engineering work or the legal work, or the sanitary work, or the work of diplomacy or government; but to act as an executive head, and direct all the various activities on the Isthmus.

The critics of the Commission might answer, on the other hand, that the work on the Isthmus demands an executive head who is on the spot, able to make and carry out prompt decisions when emergencies arise. That while the Commission is a Board of Directors, it is also a President and a General Manager. That Congress in creating the Commission and the President in appointing it contemplated a Commission which should devote its entire energies to the work; to act as a Board of Consulting Engineers, always on hand to advise and assist the Chief Engineer; to adjust the complex relations with the Panama Government and adjudicate the causes of dispute that may arise; to study the large problems of economic construction, sanitation, personnel, traffic, and a thousand and one other matters and give to their solution their entire best energies.

Doubtless other motives may enter into some of the criticisms of the Commission. Personal jealousies may be to some extent a factor, on the part of unsuccessful aspirants to a place on the Commission. Some politicians may be glad to see offices abolished which were filled without regard to politics and solely on the basis of ability of the candidates. Certain interests which have been looking toward Panama as the place to reap a fortune through speculations in contracts would doubtless rejoice to see the Commission wiped out. All these unworthy motives for criticism, however, cannot divert attention from the main question at issue, which must, sooner or later, be decided on its merits.

And now having reported the facts as we find them, without fear or favor, we cannot avoid the unpleasant duty of saying that it must be a source of great regret to the engineering profession that any cause for public criticism of the Canal Commission and particularly of its engineer members has arisen.

It will be recalled that the law creating the Commission was enacted in response to the insistent representations of engineering organizations and engineering journals. We held and still hold that in no other way can the efficient and economical and *honest* construction of the canal be so well assured as by placing the entire work in charge of a thoroughly competent commission made up largely or wholly of engineers. We held and still hold that such a body, properly constituted, is the best safeguard possible against the misuse of the canal to advance the interests of politicians or to furnish a field for the grafter and adventurer. We held and still hold that the ablest engineers in the profession ought to conduct the work and the biggest and broadest of them all ought to be members of the Commission.

We do not believe that Congress made any mistake in creating the Commission and if it should now proceed to abolish it, we believe it would be a most disastrous error.

Let it be understood again: We hold no brief for the Commission or its members. We should consider the abolition of a few highly-paid engineering positions a matter of comparative unimportance. Not in the interest of a few engineers or even of the engineering profession; but in the public interest, we consider it of the highest importance that the Commission plan of control should be retained intact.

If it is desired that the members give their entire time to the work and any of the present members find it impossible to do this, let others be selected in their place. There will be no difficulty in securing men of both ability and reputation who will be willing to do this and who will deserve and command public confidence.

We are aware that it has been jauntily said at Washington, that a Commission is a sort of necessary evil in the preliminary stage of the enterprise but that now it is fairly launched, a Commission will have little to do.

Such an opinion would only be expressed, however, by one unfamiliar with the thousand perplexing problems that arise in the course of any great engineering work. At the present time, for example, a momentous decision must be made as to the type of canal to be built. While that decision must be made eventually by Congress, the presentation of the data and the recommendation as to action, without which no intelligent decision can be made, is the task of the Commission and one which demands the profoundest engineering knowledge and the most judicial mind.

It would be a serious mistake to place on one single engineer, no matter how talented and experienced, the task of deciding a question of such grave importance. A concensus of opinion of the best minds available is demanded, and for such an opinion the public looks with confidence to the Commission.

So, too, with many other questions which will arise during the progress of the work. A demand will arise for broad and intelligent action on a thousand different matters, where it would be unwise to place on one man the entire responsibility of a decision.

Whatever action Congress may take, therefore, it is to be hoped that in some form or other the Commission plan of conducting the canal work may be left unimpaired. If that is done, the President can certainly be trusted to see that the personnel of the Commission is properly constituted, and that its work is efficiently performed.

## LETTERS TO THE EDITOR.

### Earthquakes and a Sea Level Canal at Panama.

Sir: With several years experience in tropical America, I wish to sound a note of warning to the Panama Canal Commission. I think it will be a sad mistake to undertake anything but a sea level canal, on account of the constant menace of earthquakes to the stability of ma-

sonry locks. One of those severe twists would make the canal on the upper level look like thirty cents.

Yours truly, R. S. Blinn.

Columbus, O., Dec. 22, 1904.

(This matter was thoroughly investigated by the Isthmian Canal Commission when the relative merits of the Panama and Nicaragua routes were under consideration. The conclusion then reached was that the liability to earthquakes should not be given undue importance in either the choice of a route or decision upon the type of canal to build.—Ed.)

### More about the Cracking of Ashlar Backed with Concrete.

Sir: Noting the article in the issue of Dec. 15 concerning a wall built by "Ashlar," I wish to say, as an observer of his work, that the walls referred to are retaining walls, and what is generally considered second-class ashlar masonry with concrete backing. The cut stones are laid, and the concrete is carefully deposited behind them. The work is well done, in a good, workmanlike manner, under close and competent inspection. The cracks referred to are more or less vertical, occurring at intervals of about 200 ft. The cracks open in the vertical joints, occasionally causing the stone next above or below to crack, and occasionally loosen on the bed to the next stone.

As an interested observer, I would ask what effect such cracks would have on a retaining wall, considering the foundations to be firm and unyielding, and of cross-section at the surface of the ground on the face side equal to half the wall height. Yours truly,

"Interested Observer."

Washington, D. C., Dec. 22, 1904.

### Another Magnetized Transit.

Sir: Referring to Mr. C. W. Coman's letter in the current issue of the Engineering News, we beg to state that several years ago we received in our shop a transit for repairs, which showed the same peculiarities as Mr. Coman's. After a careful examination of the same, and testing the needle at all points, we finally found that the brass casting of which the compass plate was made contained a very small portion of iron, but sufficient to make the magnetic attraction. We therefore put in an entirely new plate, in which the material was entirely brass, and since then our customer has had no further difficulty with the instrument. We can do the same for Mr. Coman's, and if he will ship the instrument, we can give him an estimate of the cost. Yours truly,

The Wm. E. Stieren Co., Inc.,
F. G. Stieren, Treasurer.

Pittsburg, Pa., Jan. 7, 1905.

### What is an Official Perch of Masonry?

Sir: Will you please state through the columns of your paper what is an official perch of masonry as recognized by the United States Government. I have been measuring some 2,000 perches, and figured 24¾ cu. ft. to a perch, and the contractor has sued me, claiming 22 cu. ft. is a perch. I think I am right. What is your opinion? The agreement reads "per perch," not signifying any given number of cubic feet. Yours truly,

Jas. Kissick & Co.,

4138 Market St., Philadelphia, Pa., Jan. 3, 1905.

(What constitutes a perch of stone has been the subject of many disagreements and not a few lawsuits. A correspondent in our issue of Oct. 20, 1904, cites a case in the West where it was held that 16½ cu. ft. is a perch. There are localities in the East where 22 cu. ft. is the commonly accepted size of the perch. There is no law defining the size of a perch, and, in case the specifications fail to state the number of cubic feet in a perch, local customs will govern a court decision.—Ed.)

### Tides on the Great Lakes.

Sir: In your issue of January 5, you have an abstract of a paper read before the Western Society of Engineers by Mr. A. W. Shaw on so-called tides of Lake Michigan. The writer noticed this same state of affairs, as Mr. Shaw describes it, during the summer of 1903. Being employed by the U. S. Lake Survey in establishing a self-registering water gage* on the pier at Milwaukee, Wis., a good opportunity was afforded to observe this fluctuation and to record its extent and duration.

There is undoubtedly a tide on Lake Michigan and on all the Great Lakes for, as some old hydraulican has said, there is a tide in a tea cup. The tides on the Great Lakes due to the moon may or may not be appreciable, but they are lost sight of in the other disturbances of the water level, among which is the disturbance or fluctuation noted by Mr. Shaw. This fluctuation is undoubtedly due to a difference of barometric pressure at the extremities of the lake. The water in the lake acts as an evenly balanced scale and weighs the atmospheric pressure at each end (or side). Frequently preceding a heavy storm the self-registering water gage recorded fluctuations of two feet or more coming in and going out as large tidal waves with a period between high and high, varying from twenty minutes to more than an hour. It was apparent that the elapsed time between high and high depended on at what points on the lake the barometric pressures created the wave. If the wave was created by a difference of pressure at points on the east and the west sides of the lake (approximately 90 miles) then the wave would travel across and back in a much shorter time than when set in motion by a difference of pressure at the north and south ends. The waves of duration of 20 minutes between high and high were probably waves traveling across the lake.

It is really the same thing on a large scale as what would happen if we were to take an oblong basin of water and set a wave traveling lengthwise or crosswise by tilting motion. The geographical situation of Milwaukee is such that waves traveling the length of the lake would show on the record going south, and again going north in a less time than the next trip south.

Lake Erie is much more interesting than Lake Michigan for here the effect of the wind is added to the barometric pressure in producing violent fluctuations. Lake Erie lies in the direction of the prevailing winds and the variation such as Mr. Shaw describes as occurring at Chicago, has at Buffalo been more than 13 ft. This was unusual and was a rare combination of great difference of barometric pressure and heavy winds. One very interesting thing in connection with this great fluctuation on Lake Erie was that when the government gage at Buffalo began to show a rise, the government gage at the west end of the lake began to show a corresponding fall at almost the same instant.

There are many interesting things in the hydraulics of the Great Lakes which will develop with the mass of information being collected by the U. S. Lake Survey.

Respectfully yours, Clyde Potts.

902 Whitehall Bldg., New York City, Jan. 6, 1905.

*Self-Registering Water-Gage, designed by Mr. E. E. Haskell, Principal Assistant Engineer, U. S. Lake Survey.

### Further Discussion of Ritter's Formula for Reinforced Concrete Beams.

Sir: Mr. John Hawkesworth, in Engineering News of Jan. 5, 1905, has erected an interesting little piece of mathematical work on poor foundation, for he labels the quantities c and f intensities of stress, whereas they should be "intensities of stress at unit's distance from the neutral axis."

At distances u and y from that axis, these intensities are then respectively cu and fy, and, when multiplied by the proper areas of cross section, furnish stresses which must be equal. That is—

$$\text{cu.}\ \frac{2}{3}\ \text{bu} = \text{fya} \quad \ldots\ldots \qquad (1)$$

But, as Ritter truthfully says,

$$\left(\frac{c}{E_c} = \frac{f}{E_f}\right) \qquad (2)$$

Transposing and substituting values of Equation 2 in Equation 1, then

$$\left(\frac{2}{3}\text{c. (ub} = \text{a}\left\{\text{c.}\ \frac{y}{u}\ \frac{E_f}{E_c}\right\}\right)$$

or Mr. Hawkesworth's equation, and also Prof. Ritter's.

A thorough understanding of the quantities in the Theory of Flexure would have enabled the writer to answer his own question.

"Engineer."

New York, Jan. 6, 1905.

### Is the Prismoid Formula Commonly Used?

Sir: Why do engineering professors teach their students to figure earthwork by the complicated prismoid formula, when the average end area method is used in practice? In this region computations of earthwork are done by the end area method even in rock, except when one area is nothing (a point), when the prismoidal formula is often used. Masonry is figured by the prismoidal formula, of course. Yours truly, Horace W. Sheley.

Salt Lake City, Utah, Dec. 19, 1904.

(In our issues of Dec. 13, 1900, Mar. 7, and Apr. 18, 1901, will be found discussions of the use of end-area and prismoid formulas. The statement was made by one of our correspondents, in our issue of Mar. 21, 1901, that he believed fully 90% of all railroad excavation was computed by the mean-end-area formula. Certainly a very large percentage of earthwork in America is computed by the simpler method. Attention may well be called, however, to a decision of the Supreme Court of California, rendered six years ago, to the effect that the prismoid formula should be used where specifications fail to mention the method of computation. The case was Scanlan v. San Francisco & San Joaquin Ry. Co. In New York and some other states, on the other hand, the law prescribes the average-end-area method.—Ed.)

### The Facts Wanted Regarding the Panama Canal Administration.

Sir: A large number of engineers throughout the country will take the examinations for the Panama Canal because of their assurance that the present Commission is composed of engineers of reputation, and they will refuse to go down there to become involved in any scandal or serve under a non-engineer commission.

I enclose a note from to-day's "Boston Herald" and hope you can get the facts and present them before Jan. 18, when the examinations will begin.

Respectfully, U. C. H.,
Assoc. M. Am. Soc. C. E.

Lawrence, Mass., Jan. 9, 1905.

(The clipping enclosed is printed below. We have discussed the causes of dissatisfaction with the Canal administration on our editorial pages.—Ed.)

WASHINGTON, D. C., Jan. 7, 1905.—Among other things, the isthmian canal commission is being charged with flagrant extravagance, which it will be called upon to explain when its members are called before the House committee to show cause why the commission should not be abolished. It is charged that one of the main reasons of the President for advocating the abolishment of the commission is the fact that it has been indiscreet in offering sinecures to persons in its employ, and that its expenditures have been far out of proportion to the actual work thus far performed.

The Mann bill for abolishing the commission will be considered by the House committee on interstate and foreign commerce next Friday.

### The Prevention of Efflorescence on Concrete.

Sir: I have read the article in Engineering News of Dec. 22d, on the subject of prevention of efflorescence in concrete, with a great deal of interest. The conditions described in your article are those the results of which have been most difficult of prevention in the past, and constitute a more unsightly defect than what is ordinarily considered as efflorescence. The latter, as stated, very frequently washes off entirely in the course of a short time, while, on the other hand, salts which are dissolved by percolation of the moisture and released by a non-permeable seam, disfigure concrete work permanently.

On a large amount of work recently built under my direction, the prevention of this seepage of soluble matter, as it may be termed, has been almost entirely successful, and in such a manner that it practically verifies the theory of its cause set forth in the article referred to. The process is very simple, involving only the careful and thorough cleansing of the surface of the concrete after it has set, and before fresh concrete has been deposited.

An examination of the top surface of concrete which has been allowed to set over night will show the presence of a very thin layer of material of a soapy consistency. No amount of rich mortar will prevent the seepage of moisture from the joint unless this soapy material is removed. On the other hand, if it be removed, the results indicate that a cure has been effected. Scrubbing with wire brushes, together with a thorough flushing with a stream of water from a hose, will remove this layer without difficulty, and at low cost.

In all of the work referred to, the concrete was made of a very soft consistency, and when first deposited had from ½-in. to 1½ ins. of water standing on top, all of which would disappear during the night.

Yours truly, C. H. Cartlidge, M. Am. Soc. C. E.,
Bridge Engineer, C., B. & Q. Ry.

Chicago, Ill., Dec. 30, 1904.

### Another Letter Press for Emergency Use.

Sir: On p. 91 of your issue of July 28, 1904, I noted the description of an emergency letter press. Curiously enough, about two years ago at an auction here I picked up one of almost identical description except that the balancing springs were missing.

However, I can offer even a simpler method of copying letters which does away altogether with a press. It is as follows: Wet the tissue paper page, then dry a little by lightly pressing a large sheet of blotting paper (or by standing if no blotting paper is available) over the wet page; next lay the letter to be copied on the wet page, then, closing the book, stand on it directly with your feet so that your whole weight will come on the book, and, by moving about, bring the pressure on all parts of the page. Now open the book with the first oiled sheet to your right, stretch the sheet slightly to bring it taut, and then peel it off from the center of the book out; this leaves the tissue paper page still adhering to your letter. Now snap the excess water out of the copy brush and brush the page quite vigorously; this will bring all parts of the copy sheet closely in contact with your letter, and a fine copy is the result.

I gave up my press as unsatisfactory, as I found it necessary, usually, to brush the page as above described. The necessity of brushing the page suggested to me the idea of giving up the press.

The eccentric lever, even with your weight on the lever, gives a rather light pressure when distributed over 10 × 8 ins. of surface. A person's weight of some 150 lbs.,

concentrated on 3 or 4 sq. ins., brings the papers more effectively in contact, and the brushing finishes the job.

Yours truly, E. P. Osgood.

Office of the Electrical Engineer,
Local Sanitary Department, Bangkok, Siam,
November, 1904.

### Medical Provision for Field Parties.

Sir: I once knew an old whaling ship captain who at the beginning of a voyage would take all the medicines out of the ship's medicine chest. The light-colored ones he mixed in one demijohn and the dark-colored ones in another; then when a sailor came to him for treatment the captain drew an imaginary line across the patient's anatomy and, according as the pain was above or below this line he dosed the patient from the jug containing the light or dark mixture. The results were surprising, and, so far as the captain was concerned, highly satisfactory, for it soon became a rare thing for a man to report himself as sick.

Many field engineers in charge of work, often far removed from any physician, either adopt similar rough and ready measures for treating their men, or else give no thought to the hygienic matters, and omit all provision for the care of illness or injury. Surely such a course in this day of enlightenment is foolish and inhuman. Every engineer should know something about first aid to the injured, and the man in charge of construction work who fails to do so is criminally negligent. The number of men whose lives might have been saved, or whose sufferings lessened by some one who knew how to put on a tourniquet, or protect a broken bone, is very great. Columbia University's School of Applied Science, in giving a course of lectures on the subject to the members of the graduating class, is taking a step in the right direction, which might well be followed by other technical institutions. Some of the life insurance companies issue books on what to do in an emergency, and no engineer can more profitably use a postal card than in sending for a set, and keeping them near at hand for the next accident.

Elihu Cunyngham Church.

4 East 130th St., New York, Nov. 30, 1904.

(A symposium on Medical and Surgical Kits for Engineers was published in our volume for January-June, 1903, pp. 101, 404 and 538.—Ed.)

### Flattening and Cracking of Cast-Iron and of Vitrified Pipe Under Earth Pressure.

Sir: It would be interesting to know just how the back-filling was done over the 4-ft. cast-iron pipes, the flattening of which after back-filling was described by Mr. Walter W. Patch in your issue of Dec. 15, 1904.

If the filling was dumped from carts and allowed to adjust itself to its new location, with no attempt at leveling, tamping or puddling, as I saw trenches filled over a pipe of similar size in Newton, Mass., a year or two ago, a fill of 22 ft. might well be considered a heavy load. But if the back-filling was properly tamped or puddled, the sides of the pipe would receive a supporting pressure from the compacted earth, while the weight of the covering, bearing directly on the pipe, would be much reduced.

The description of seven breaks in a 48-in. pipe, near Boston, described in Engineering News of July 3, 1902, shows them to have been longitudinal cracks the full length of the pipe. I think they were under a fill of about 7 ft.*

Some ten or twelve years ago I read an account of a cast-iron pipe being cracked under a railroad fill of something like 75 ft. I think I read this description in the Engineering News, but I have examined my files since 1888 and failed to find the article. As I recall the item, a pipe of about 6 ft. diameter was used as a culvert under a fill of about 75 ft., somewhere in Western Pennsylvania. A portion of this pipe cracked longitudinally, in a similar manner to those already described.

Several years ago I laid a 20-in. Akron pipe in a trench about 6 ft. deep. During my absence, a portion of the trench was very carelessly filled, and I think a small quantity of frozen lumps of earth mixed in with the filling. After the entire line was completed, I had the interior of the pipe inspected by a man, who crawled through about 300 ft., between manholes. He reported 30 lengths of pipe cracked. On again opening the trench I found each of the 30 lengths of pipe had cracked longitudinally its full length along top, bottom and each side, and the drain was thus made up of a series of four curved pieces or slabs laid together, forming an elliptical area. At the top and bottom the cracks opened about 3-32-in. on the interior of the pipe, and the side cracks had opened a like amount on the exterior of the pipe, so the vertical diameter had diminished, while the horizontal diameter had increased proportionally. My measurements of the cracks and the distortion of the pipe are not at hand, and I am unable to give exact figures. It is very probable that if this Akron pipe had possessed the same elasticity that the cast-iron pipe had, it would have taken the elliptical form without cracking, and have been practically as good as when first laid.

Truly yours, William P. Snow, M. Am. Soc. C. E.

Auburndale, Mass., Dec. 26, 1904.

*(Four, and possibly five, of the breaks were in heavy fills; two were in fills of only 4 ft. One theory advanced in the article was that the pipes, having been laid in very cold weather, small cracks had existed for years, which enlarged with a sudden increase of pressure.—Ed.)

### Proposed Utilization of Upland Flood Waters to Increase Available Underground Waters.

Sir: I have read with interest Prof. J. Gustav Richert's paper on "The Progressive Sinking of the Ground Water Level and Artificial Ground Water Supplies" (Engineering News, Nov. 24, 1904). The artificial storage of ground waters is a problem in which I have been much interested, and upon which I have been experimenting for the past fifteen years. My experiments to date lead me to believe that this method of increasing the available supply of water in many sections of the Southwest is the only hope for extending the development of horticultural and agricultural improvements.

At the request of some of my clients, I recently published my views upon this subject in a local paper, and herewith inclose a copy of same for your consideration.

Yours truly, F. E. Trask, M. Am. Soc. C. E.

Los Angeles, Cal., Nov. 30, 1904.

(Mr. Trask's general plan is stated as follows:

That the winter and storm discharge of the many rivers and streams of Southern California be diverted at the mouths of canyons upon the debris cones of said canyons; that these waters be not allowed to run in the present channels, but that they be diverted from place to place over the porous sand, gravel and rock surface, to the end that all water may be absorbed by the debris cone; that districts be established for each of these water sheds; that the organization of each district be effected by uniting corporations and persons interested in maintaining the supply of underground water and beneficiaries of the proposed work, and that each organization maintain a force of laborers at all times sufficient in number to divert and dissipate all waters not used directly for irrigation, with the possible exception of extreme floods, which should be kept in the natural channels.

In general terms the work should be a diversion dam, located near the mouth of the canyon, at such a point that the water could be led out upon any and all of the open and porous gravel and rock forming the great mass of the debris cone. This dam should be constructed with a full knowledge of the necessity of passing the maximum floods down the old natural channel. In some places it might be a temporary structure that would give way to dangerous floods, while in others a more permanent construction would be advisable.

The main diversion conduit should be a wooden flume or pipe, in sections suitable for rapid dismemberment, relocation and reassemblance. In most cases a few hundred feet would be quite sufficient. The discharge should be split up into small streams and spread out fan-shape over the debris cone, with a constant shifting of the streams, to the end that these small channels may not be silted up and made impervious. Some locations might require the digging of ditches and building of dams along the contour lines and at right angles to the surface drainage grades, to intercept and to redistribute any collected water resulting from the saturation and silting up of the gravel beds lying above the ditch or dam.

Mr. Trask states that during years of small rainfall stream channels become cemented so that little of the stream flow, after allowing for evaporation and for diversion by irrigators, reaches the underground reservoir formed by the debris cones. Heavy stream flows destroy the impervious linings, thus admitting water to the underlying gravel or sand.—Ed.)

### Spring's Formula for the Limiting Loads of Wheels Rolling on Rails.

Sir: My attention has been called to a paragraph in your editorial on Mr. Spring's paper on the "Permissible wheel load per ft. of wheel diameter and per inch of breadth of the rail" (see p. 455 of your issue of Nov. 9, 1903).

You say that although no one will doubt that a large wheel may safely be loaded more heavily than a small one, "yet there is no reason why its safe load should be exactly proportional to its diameter."

The following investigation will I think convince you that there is good reason for accepting this relation.

The surface of a new rail is round and the surface of the tire is either cylindrical or conical. The contact is therefore a point, but under pressure this becomes a small area owing to the elastic "giving" of the material. This small area is much bigger on a worn rail, which we may take as representing normal conditions, owing to the top of the rail having been worn flat to fit the tire and contact is then a line stretching across, or almost across, the head of the rail and widened out (in the direction of the length of the rail) under pressure. The question is: Given the weight of the wheel and the length, b, across the rail of the contact (G B or F A, Fig. 1), how much will the area spread out under pressure along the length of the rail, i. e., the length A B. When we have solved this it is an easy geometrical problem to find the max. deformation (E D, Fig. 2) and from it the max. stress at the surface of contact in terms of the radius of the wheel and the load. Fig. 2 shows the side view, exaggerated, of course, of the wheel on the rail, the dotted line being the deformed surface of contact.

Assuming both the rail and the tire to be equally hard, the deformation of each will be the same, and the dotted line A E B lies midway between A D B and A C B.

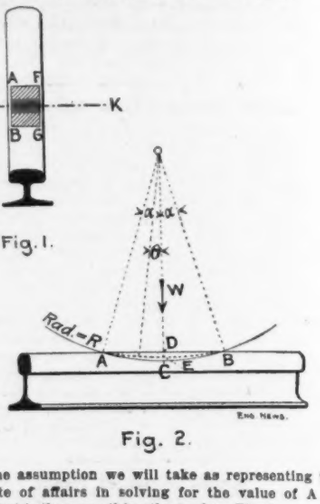


Fig. 2.

This is the assumption we will take as representing the normal state of affairs in solving for the value of A B, Fig. 1, or what is the same thing the angle $a$, Fig. 2.

If either surface be harder than the other, it will deform less, and the other will be more deformed (and therefore more severely stressed) up to a maximum of double when one of the two is infinitely hard.

The ordinary equation of elasticity is:

$$P = \frac{E\,\omega\,l}{L} \text{ or } dP = \frac{E\,l}{L}\,d\omega$$

The latter is the differential equation and in using it we assume the area of contact divided up into elementary strips parallel to H K in Fig. 1 each of length b.

Then $d\omega = b\,R\,d\theta\cos\theta$ — For it is the horizontal projection of the area that we are considering.

$l = \frac{1}{2}R(\cos\theta - \cos a)$ — On the assumption above mentioned.

$L = R\cos\theta$

$$\therefore dP = \tfrac{1}{2}\frac{R^2\,E\,b(\cos\theta - \cos a)\cos\theta\,d\theta}{R\cos\theta}$$

$$\therefore W = \tfrac{1}{2}E\,b\,R\,2\int_0^a(\cos\theta - \cos a)\,d$$

$$= E\,b\,R(\sin a - a\cos a)$$

substitute for sin $a$ and cos $a$ their expansions in terms of $a$ and we get:

$$W = E\,b\,R\left\{a - \frac{a^3}{3!} + \frac{a^5}{5!} - \ldots - \left(1 - \frac{a^2}{2!} + \frac{a^4}{4!} - \ldots\right)a\right\}$$

$$= E\,b\,R\left\{\frac{a^3}{2} - \frac{a^3}{3!} + \frac{a^5}{5!} - \frac{a^5}{4!} \ldots\ldots\right\}$$

Omitting terms of $a^5$ because $a$ is always so small an angle that terms of $a^5$ will be only about 1/1000th part of terms of $a^3$,

$$\therefore W = E\,b\,R\frac{a^3}{3}$$

$$a = \sqrt[3]{\frac{3\,W}{E\,b\,R}}$$

This gives us $a$ in circular measure, and if we want numerically the value of A B it is 2 R sin $a$.

Now for the stress:

The maximum intensity occurs at E, and is obtained from the equation

$$p = \frac{E\,l}{L}$$

$$\therefore p = E\,R\frac{(1 - \cos a)}{2\,R}$$

Expanding cos (a) as before and neglecting $a^4$

$$p = \frac{E}{2}\left(\frac{a^2}{2}\right) - \frac{E\,a^3}{4}$$

Putting in value of $a$ from the above equation

$$p = \frac{E}{4}\left(\frac{3\,W}{E\,b\,R}\right)^{2/3}$$

$$= 0.52\,\sqrt[3]{E}\left(\frac{W}{b\,R}\right)^{2/3}$$

From which it is evident that the fraction $\frac{W}{R}$ must re-

grain constant to maintain a given value of p. That is, so long as b does not vary, i. e. in a given rail and tire.

In other words the safe load on a wheel is exactly proportional to the diameter.

It should be noticed that if excessive weight is put on the wheel the stresses at the point of contact do not go up in proportion to the increase of W, but only in proportion to the ⅔ power of W.

G. E. Lillie,
Dy. Consulting Engineer.

Bombay, Nov. 7, 1904.

## EARTHWORK OF THE SEATTLE AND LAKE WASHINGTON WATERWAY CO.*

By C. H. Rollins.†

CONCEPTION AND OUTLINE OF SCHEME.—Some time in 1890, Hon. Eugene Semple conceived the idea that two things long desired by Seattle citizens, namely, the connection of Puget Sound with Lake Washington by means of a canal, and the reclamation of the tide lands lying at the head of Seattle Harbor, might be obtained by a combination of the two projects.

His idea was to cut the canal at a point which would give the shortest distance between the waters of Puget Sound and of Lake Washington, and at the same time furnish sufficient material to fill the tide lands.

Beside the primal objects of this scheme (the canal and the filling of the tide lands), there would be the possibility of keeping the water of the lake at its low or summer level, this height to be regulated by locks and spillways of the canal, thus diminishing, if not entirely preventing, the floods in the Duwamish valley, and at the same time obtaining a large water power from the surplus water. There would also be ample facilities for railroad connection between the tide lands and the lake, along the bermes of the canal, and for future sewers to drain that portion of the city between the lake and the Sound.

In 1893 a bill was passed in the Legislature of this State authorizing any person or company to excavate waterways through tide and shore lands, and with the material so excavated to fill tide and shore lands in front of incorporated cities. It gives to the person or company performing the work a first lien on all such lands as they may fill, for the cost of the work, plus 15% profit. It authorizes streets and public places to be filled and bulkheads to be constructed, and the cost thereof, plus 15%, to be added to the lien on the lands benefited. The liens attach and certificates are issued therefor, from time to time, as the work progresses on the waterways and on the filling made from their excavation. The waterways are to be free, except where locks or tide gates are necessary, when a reasonable toll may be charged.

Upon the passage of this law, Mr. Semple formed the Seattle and Lake Washington Waterway Company to carry out the plan, in regard to Seattle. Exhaustive investigations were then made into every feature of the proposed work by Captain, now Colonel, Thomas W. Symons, Corps of Engineers, U. S. A., who made most favorable reports on the project.

The tide lands were surveyed under the orders of the State Board of Tide Land Appraisers, by the late M. Stixrud, C. E., and the present tide land plat was made by him, under the direction of V. G. Bogue, C. E.

Based upon the above act of Legislature and the tide land plat, contracts were awarded by the State to the Seattle & Lake Washington Waterway Co. in 1893, '94 and '95, for the excavation of the canal and various waterways and the filling of practically all the Seattle tide lands at the head of Elliott Bay.‡ The total area to be filled is about 1,500 acres. The total volume of this fill will be roughly between 28,000,000 and 30,000,000 cu. yds.

The total amount of material obtainable by dredging from the waterways is 9,000,000 or 10,000,000 cu. yds.

The total volume of material in the canal cut will be 20,000,000 or 22,000,000 cu. yds.

MAKING SOUNDINGS.—Field work in preparation for the actual work of dredging and filling was begun in May, 1895. This consisted of establishing base lines from which the waterways, streets, blocks, etc., could be located in accordance with the tide land plat, and from which also the lines for cross-sectioning are run. It was determined that the cross-sections should be taken at intervals of 20 ft., and this, owing to the large area to be covered, has proved to be the most laborious part of the field work. Most of this work is done by sounding with lead and line, or light rod (according to the depth of the water), from a boat. The level is used only along the shore line. The method pursued in sounding is as follows:

At right angles to a base line spaced in 20-ft. stations, a raft is anchored at any convenient distance, up to about 2,000 ft., being lined in the proper position with the transit. A wire tagged every 20 ft. with colored cloth, with a different color for the 100-ft. marks, is then made fast at the base line and payed out from a reel in a boat till the raft is reached, when the reel is secured to the raft and the wire wound up as taut as possible. If the distance between the ends of the wire is more than a few hundred feet, it is necessary to place enough small rafts, made of plank, with a light framework above them, under the wire to hold it entirely above the water. These rafts must be anchored against wind or tide to keep the wire in as straight a line as possible. The most satisfactory wire for this purpose has been found to be a galvanized iron wire of several strands (known as seizing wire), the size of the ordinary clothes line wire, which can be procured in any desired length. A tide gage having been previously set at some convenient point, and a man stationed to observe and note the time of each tenth of a foot of rise or fall of the tide, the wire being stretched, all is ready for the sounding. This requires a leadsman, one or two oarsmen and a recorder to note the stations, the depth of the soundings, as called by the leadsman, and at frequent intervals the time. From the notes thus taken, after the readings of the tide gage are entered with them, the elevations of the bottom are readily reduced. It has been found unnecessary to stretch the wire for each line of soundings, as with range sights on the base line, and a practiced crew, there is no difficulty in doing sufficiently accurate work up to 40 ft. from the wire, so that it has become the practice to cover five lines of sounding with each stretch of the wire, one line under the wire and two, respectively 20 and 40 ft., each side of it. In this manner about 800 acres of the tide lands have already been cross-sectioned. Beside this work, the field work, up to the present time, has consisted of establishing bulkhead lines, setting grades for the filling, taking levels over the completed work and cross-sectioning on the line of the canal.

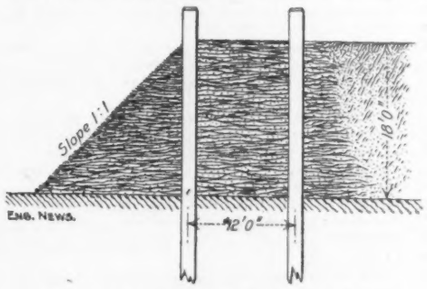


Fig. 1. Permanent Brush Bulkhead.

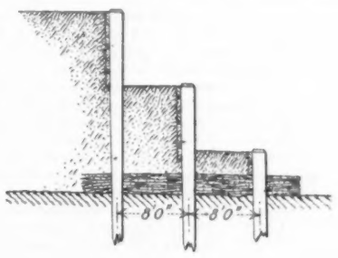


Fig. 2. Temporary Bulkhead.

DREDGING.—The greater part of the excavation has been done in the east waterway by hydraulic dredges of the Bowers pattern. A description of these will be unnecessary here. I will leave that for some one better qualified and confine myself to some account of the results of their operation.

The material moved has been almost entirely a heavy, dark sand, with occasionally a small amount of silt. Well borings made near the southern end of the tide lands have shown this bed of sand to have a depth of about 150 ft. Dredging was begun at a depth of about 35 ft. below low water at the entrance to the east waterway in July, 1895, and this depth has been maintained for a width of 700 ft. and for a distance of 5,000 ft., except that it has been necessary to leave a dyke across the waterway at the crossing of the railway trestle, for its protection until it is either rebuilt or removed. Dredging was continued until June, 1897, and during this period an area of 62 acres was filled to grade, requiring 1,433,000 cu. yds. of material. In August, 1900, dredging in the east waterway was resumed, and since that time an area of 174 acres has been filled, requiring 4,520,000 cu. yds. of material, making in all 5,953,000 cu. yds. dredged from the east waterway.

In October, 1903, dredging was begun at the entrance to the west waterway, from which 463,000 cu. yds. have been excavated, completing it for a distance of about 600 ft. This material has sufficed to fill an area of 18 acres between the two main waterways. Dredging is now being carried on in the west waterway, and the material obtained used in filling the above territory.

METHODS OF CONSTRUCTING FILL WITH DREDGED MATERIAL.—The method adopted in constructing the fill during the first period of the work was as follows: One side, that along the contract line south from King St., on Railroad Ave., was retained by a brush bulkhead. The remaining boundaries of any given district were dykes built of sand, with straw or hay bedded in it and kept a little above the general surface of the fill. At some convenient point within the district a vertical sluice box was built, from the bottom of which another box extended horizontally beyond the fill. The fill was made sloping from all sides to the sluice, the sides of which were kept enough above the fill to provide a settling basin around it so that little beside water escaped. When the district had been brought to grade the sluice was filled, and the same routine continued in the next district.

Since the resumption of work in August, 1900, this method has not been followed. Instead of the dykes, bulkheads of piles and plank have been used to enclose the districts, allowing them to be brought to grade much more quickly, as it is unnecessary to place any material outside the lines of the district. In constructing the fill with these bulkheads, a wide sluice is built of plank at a point where the waste will run into the next district to be filled. At the inner end of the sluice the planking of the bulkhead is kept enough above the level of the fill to provide a settling basin, to prevent as much as possible the escape of material with the waste water.

BULKHEADS.—Of the various bulkheads used, the brush bulkhead is the most important, as it is intended to be a semi-permanent structure; and, in fact, some of it that has been in place for about nine years is still in very good condition. The bulkhead originally planned for the use to which the brush has been put was a sheet pile affair, which was decided to be insufficient before any of it was built. The original plan for the brush bulkhead was to drive piles in two or more rows, according to the height of the fill, the rows 10 ft. apart, the piles in the rows 6 ft. apart. Around these the brush (young fir) was to be so laid, with the butts outward, as to give a slope of 1 to 1 or 1½ to 1 to the face of the bulkhead, which should have a top width of about 12 ft. and a base not less than 1½ times the height. At intervals of 3 ft. in height poles were to be lashed to the piles with wire to hold the brush in place, and at frequent intervals small trees were to be placed in the brush, with the tops extending well into the fill, to the more securely bind the bulkhead and fill together.

This plan has been much modified, as it is thought that the more homogeneous the mass of brush can be made the greater is the strength of the bulkhead; in fact, if the brush could be held in place without piles or any bracing until it was firmly embedded by the material of the fill, it would be so much the better. Hence the longitudinal and other braces have been abandoned entirely and the number of piles much reduced. In construction the brush is kept only slightly above the level of the fill, to allow the material to penetrate it as far as possible. The brush is held in place temporarily by spiking plank across it to the piles. These planks are moved as more brush is laid, and this is the only bracing used, and is also the only use to which the piles are put.

It has been found practicable to finish a fill by wasting through the brush, without other sluiceway, as the brush holds nearly all the material and the waste water escapes almost perfectly clear.

In the temporary pile and plank bulkheads, the piles are driven 8 ft. apart in two rows, 8 or 10 ft. apart, according to the height of the fill. The outer row of piles is braced with 1½-in. plank to the inner, and as the fill is raised the inner row is braced in the same way to anchors made of plank, bedded in the fill itself. Planking is spiked to the inside of the outer row of piles to half the height of the fill, and when the fill has reached this point the remainder of the planking is placed on the inner row. Plank 1½ ins. thick has been found to have sufficient strength for this purpose, even for fills of more than 18 ft., and this thickness is used, except where the bulkhead is expected to maintain itself for a year or two; in such instances 3-in. plank is used.

In several places where it has been inconvenient to use a pile driver, posts have been used instead of piles, the outer row being set 3 or 4 ft. in the bottom, and that and the succeeding rows braced and anchored in the same manner as the pile bulkhead just described.

At first the steps in this form of bulkhead were given a rise on only 4 or 5 ft., but in the bulkheads around the fill made from the canal cut, where only this bulkhead is used, the rise has been increased to 6 and 7 ft. Here the posts used have been 4 × 6 ins., spaced 6 ft. apart, the outer row driven 3 or 4 ft. in the bottom by the use of a small hand pile driver. The inner row is simply set in the bottom and all are braced and anchored as before described. The plank used is 1½-in.

This bulkhead has been found inexpensive and satisfactory for the purpose.

THE CANAL.—In November, 1901, excavation of the canal cut was commenced. This, when completed, will be a trifle under two miles long, with a maximum cut of 320 ft. The canal prism will be 60 ft. wide on the bottom and 35 ft. deep below low water. The canal at low water

*A paper read before the Pacific Northwest Society of Engineers, May, 1904.

†Chief Engineer, Seattle & Lake Washington Waterway Co.

‡For previous descriptions of this work see Engineering News, Mar. 16 and July 12, 1894; Jan. 24, 1895; and Dec. 31, 1896.

will have a width of 140 ft. At 7 ft. above the low water line there will be bermes 15 ft. wide on the south side and 45 ft. on the north side. From this point the slope proposed is 1¼ to 1. At the west end of the canal there will be a lock 720 × 90 ft., in the clear, with an intermediate gate, so that the entire lock need not be used for small vessels. The lift will be 32 ft. The construction is planned to be of timber cribbing and concrete. At the east end of the canal there will be a guard lock of similar construction.

It will be necessary to carry the city's Cedar River water supply under the canal in a tunnel, and a drawbridge will have to be built at the western end of the canal, and at its crossing of Rainier Ave. An overhead bridge will also have to be built somewhere near the summit of the cut.

METHODS EMPLOYED ON THE CANAL.—While the results obtained have been more or less satisfactory, this work has been, and still is, so largely experimental that it is somewhat difficult to draw conclusions from the methods that have been used, or in fact to do anything more than state a few bald facts.

So far the excavation has been made exactly as it is in ordinary hydraulic mining operations. The water supply is the surplus from the city's Cedar River system, delivered at the Beacon Hill reservoir, at times augmented by water from the old city pumping station at Lake Washington. From the reservoir the water is carried over a mile to the work through 30 and 18-in. wood stave pipe, and finally though 15-in. steel pipe is delivered to the giant. With the available head and volume of water, a 6-in. nozzle has been found most effective. The quantity of water used has been from ten to fifteen million gallons per day of 24 hours. The average daily excavation has been about 3,000 cu. yds. under a head varying as the work progressed in the cut from 250 to 190 ft., most of the work having been done with a head of about 200 ft.

The material encountered has been that found everywhere in the hills about here, that owe their existence to former glaciers, and consists of a conglomerate mass of sand, gravel, with some boulders, and several varieties of clay, some of the latter very refractory, requiring to be shaken up with light blasting to enable the water to penetrate it.

The cut at present is about 1,000 ft. long, 400 ft. wide and 100 ft. deep, and the total material removed from it amounts to something more than one and one-half million cubic yards. With this amount about 63 acres of the adjoining tide lands have been brought to grade.

Most of this material has been placed in the fill by the use of the ordinary miners' flume, carried on trestles. The main lines of flume have been lined on the bottom with blocks, set with the grain on end, in the usual manner, with spaces between them, the thickness of the blocks being 10 or 12 ins. This has been found to be a mistake, as the filling of the spaces with gravel causes the blocks to wear unevenly, creating unnecessary friction, and when the blocks have been worn down 3 or 4 ins. they are of little use, as they cannot be turned satisfactorily. Blocks laid close together wear much more evenly, and a thickness of 6 ins. is quite enough, as after they are worn down 3 or 4 ins. it is better to replace them. In such a flume it has been found that the material may be carried on a 2.6% grade; but with less the flume will choke; and even at that grade choking will occur unless enough clay is mingled with the sand and gravel to act as a lubricant. The material, when reaching the place of deposit, is readily spread by the use of shear boards, with some assistance from muck rakes.

It has been found to be impracticable to reach one portion of the area to be filled with the trestle and flume, and it was decided to try the use of a penstock and pipe line for distributing the material. A vertical penstock, 20 × 24 ins., inside dimensions, designed to receive the whole volume of water and material from the flume, was built of 3-in. plank, held together by collars of plank and bolts, with the lower end resting on a timber trestle, about 6 ft. above the grade of the fill. At this point a reducer of steel plate led to a quarter turn of No. 10 gage steel pipe, 20 ins. in diameter, and to this was connected 20-in. wood stave pipe, the staves 2⅛ ins. thick, in 16-ft. lengths, laid horizontally about a foot above the grade of the fill. The head obtained was 66 ft. After six hours' run through this apparatus a rivet dropped from the steel bend, its inner head having been worn off, and in less than 24 hours' run the first wooden pipe was worn through on the bottom. The steel bend was then replaced with solid timber, and the wooden pipe, for a distance of about 200 ft., with a box flume of 2-in. plank, lined with 4-in. blocks on the bottom, and held together with collars like those on the penstock. This proved to be better than the first arrangement, but was never satisfactory, as none of the construction was heavy enough, and it was impossible to stop its leaking badly. After running for about a week the upper 20 ft. of the penstock had to be rebuilt and lined with blocks, to take the wear off the stream as it shot from the flume against the side of it. The full benefit of the 66-ft. head was never obtained, owing to the disproportion of the pipe and penstock to each other, and to the quantity of water and material to be carried, the penstock being never more than two-thirds full, perhaps even less. Yet with all its imperfections it was used until the discharge pipe had attained a length of 2,200 ft. and it had distributed about 200,000 cu. yds. of material. At this distance from the penstock it was found that the pipe would quickly choke if the stream was allowed to carry more than a very small percentage of fine gravel or sand and its use was abandoned.

Another penstock has been built, taking the stream from the flume at a point which gives a head of 20 ft. This is built on an angle of 45°, of 6-in. plank, fastened together with bolts through the timber edgewise. At the bottom a short section, built in the same manner, but lined on the bottom with 6-in. blocks, receives the heaviest wear. This penstock at least does not leak, and the results obtained have been better than with the first one, as from it the heaviest material has been distributed through a pipe line 800 ft. long, and lighter material up to 900 ft. But there is still room for much improvement in both design and construction. The advantages of a penstock and pipe line over flume and trestle are the saving in expense of construction and the ease with which the direction of the discharge may be changed.

SUMMARY OF WORK DONE.—I will close with a summary of the work performed by the Waterway Co. to the first of the present year.

From the excavation of the east waterway during the first period of work, from 1895 to 1897, the area filled was 301,875.8 sq. yds., consuming 1,432,821.6 cu. yds. The amount of the certificates issued to cover this portion of the work was $267,952.48.

From excavation of the east waterway from 1900 to date, the area filled was 840,562.6 sq. yds., consuming 4,519,548 cu. yds., and the amount of certificates was $839,830.37.

From excavation of the west waterway the area filled has been 86,014.1 sq. yds., consuming 462,674.5 cu. yds., and the amount of certificates $88,035.59.

From excavation of the canal cut, the area filled has been 305,507.8 sq. yds., consuming 1,147,467.7 cu. yds., and the amount of certificates $214,126.27, making totals for area 1,533,960.3 sq. yds., or 317 acres; for volume 7,562,511.8 cu. yds., and for the amount of certificates $1,409,944.71.

The actual excavation is considerably in excess of these figures, as certificates are only issued upon wholly completed fill.

DISCUSSION BY C. E. FOWLER, PRESIDENT.

The dredging work, by which material has been excavated from the waterways to be used for filling, has been done by two 20-in. suction dredges, under contract with the Puget Sound Bridge & Dredging Co., of Seattle.

The dredge "San Diego" is equipped with a 600-HP. marine type of engine, taking steam from two batteries of water-tube boilers. The dredging pump is of a special type developed by this company, and especially adapted to handling the sand which is used from the waterways.

The excavator is of the rotary type, which delivers the material in front of the suction pipe, and digging can be done to a depth of over 50 ft. The hoisting of the spuds, the hoisting of the ladder which carries the excavator, and the swinging of the dredge is accomplished by the specially designed system of winding engines and drums. The material is forced out through a floating pipe line, which is in 30-in. lengths of pipe, carried on small scows or pontoons 24 ft. in length. At the shore, or where a lift of about 20 ft. is made at the period of high tide, a long length of pipe is supported and adjusted to various angles, by several sets of tackles hung from a derrick scow. The shore pipe is partly of steel and partly of wood, in 20-ft. lengths, and is laid either on the fill itself or on brackets spiked to piling.

The permanent bulkhead is shown in Fig. 1, and consists of two lines of piling, 12 ft. centers crosswise and 8 ft. centers longitudinally, between which, as anchors, fir brush is laid as indicated, with a face slope of 1 to 1. The sand percolates into the brush and makes a sea wall better than anything else, unless it be of rock or concrete.

The temporary bulkheads, Fig. 2, which are used away from the sea front, and which are eventually buried in the fill, are constructed with three lines of piles, 8 ft. centers in both directions, to which planking is spiked as shown, and ranging in thickness from 3 ins. for the bottom tier to a minimum of 1½ ins. at the top. In case of cutting underneath a mattress of brush is used as shown, or else sand bags are employed.

The dredge "Portland," also employed on this work, has main engines of 800 HP., and boilers of the Scotch type. The pump is of the same type as on the "San Diego," but considerably larger, discharging through a 22-in. pipe.

In obtaining material, the east waterway through the tide flats has been excavated to a depth of 38 ft. at low water, from deep water on Elliott Bay to a distance of nearly one mile southward. The west waterway has also been partially excavated, and the material used for filling a part of Harbor Island, or that district between the two waterways.

All of the completed fill has been carried up to 2 ft. above high tide. In distributing the material the length of the discharge pipe has varied from 1,500 ft. to nearly a mile in length, but at distances exceeding two or three thousand feet the pumping of sand through pipes ceases to be a very interesting problem, from a financial point of view, at any ordinary prices.

## DAY LABOR FOR MUNICIPAL PUBLIC WORKS IN CHICAGO.

The employment of day labor in the construction of municipal public works has given very satisfactory results in Chicago, and was discussed by Mr. W. A. Shaw, Assistant Engineer of Intercepting Sewers, in a paper read last month before the Western Society of Engineers. The intercepting-sewer system was described and illustrated in our issue of May 28, 1903, but Mr. Shaw's paper dealt with that part of it which was built by the city under the day-labor system, and we give the following extracts from the paper relative to this method of carrying on the work:

In August, 1899, bids were received for the south arm of the intercepting-sewer system, extending from 39th to 70th St. All bids were rejected, and on Nov. 13, the Mayor asked the common council to authorize the Commissioner of Public Works to construct this portion by day labor; the city to buy all material by duly advertised all labor to be employed directly by the city, and all construction work to be directly under the charge of the engineer. On Dec. 11, authority was granted, specifying that every laborer employed should be certified by the Civil Service Commission to the Commissioner of Public Works, in accordance with the requirements of the Civil Service Act; also that on or before the tenth day of each month the Commissioner of Public Works should submit to the city council a detailed report showing the cost of the labor and the amount and cost of the work accomplished during the preceding month.

This was the city's first experience in construction work on so large a scale; consequently it had no tools and plant. A pile driver and a swinging derrick were rented and work was at once commenced. After considering whether the city should rent or purchase a permanent plant, and whether new or second-hand machinery should be purchased, it was decided that the work should be equipped with an entirely new plant comprising the following: 1, a drop-hammer turntable pile driver; 2, a swinging derrick with 1-yd. orange-peel bucket for excavating to clay; 3, a swinging derrick with 1-yd. skips for excavating in the clay; 4, a swinging derrick with 1¼-yd. orange-peel bucket for back-filling; 5, a centrifugal pump for taking care of water ahead of the bricklayers; 6, a 60 H.P. boiler and direct-connected centrifugal pump for pumping out the completed work. The bids received were excessively high: about $4,000 for a pile driver, which cost the city $2,200 to build; and $7,000 for the derricks, which cost about $5,000. All bids were rejected, and the city proceeded at once to build the pile driver and derricks with its own labor.

In starting this work, the city had no organization, nor did it have skilled laborers familiar with this kind of work. All laborers of every description had to be hired through the Civil Service Commission upon requisitions from the Department of Public Works. With this method it took a longer time to get an organization than it would have taken a contractor, but with the city doing the work it practically eliminated politics. The working of the civil service system proved itself entirely practicable and satisfactory. The Civil Service Commission helped the department and is entitled to its share of credit for the successful carrying on of public works by day labor. Mr. F. W. Blocki, Commissioner of Public Works, is entitled to praise for the aid he rendered in keeping the department entirely unhampered from politics, and for his business methods in the carrying on of such work. Mayor Harrison was the original advocate of doing public work by day labor.

At the time I was assigned to take charge of this work, many people told me that the city could not carry on work of this magnitude by day labor, as men could not be obtained and there would be various other difficulties. I wish to make the statement that the men performed as much work per day as for any contractor over whose work I have had supervision. Bids were received on this work in the fall of 1898, and regardless of the fact that prices of material advanced from 10 to 40%, and labor for 15 to 25%, this section was completed under the bids submitted, and when completed there were no bills or suits for extras, and the work was well done.

It has been clearly demonstrated that the city of Chicago can do its own work cheaper and more advantageously by day labor than by contract. On account of the existing laws, the city is prohibited from doing any further work of this kind by day labor. In this age of trusts and combinations, legislation should be enacted to at least give the city the right to do its own work, if, in the opinion of its engineers, bids are excessively high.

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**A TERMINAL AND WAREHOUSE PLANT** for the freight transportation system of the Illinois Tunnel Co., at Chicago, is to be established at the northeast corner of Taylor and Beach Sts., west of the Chicago River, with a frontage of 400 ft. on the river and 700 ft. on Taylor St. On the property are warehouses 6 to 10 stories high, which will be utilized for receiving and storing freight, especially for the smaller concerns which have not their own warehouses.

A TUNNEL CONSTRUCTION COMPANY has been organized to take over and complete the work of the New York & New Jersey railroad tunnel, better known as the Hudson River Tunnel, and also the proposed tunnel of the Hudson & Manhattan R. R., from Cortlandt St., New York, to the Pennsylvania R. R. terminal in Jersey City. The capital stock of the construction company, which is known as the Hudson Companies, is $23,000,000, and the purpose of the organization is to construct an elaborate system of river and land tunnels connecting the railways terminating in Jersey City with down-town New York and the Rapid Transit Railway. We expect to give further details of the project in our next issue.

A REPORT ON THE MAXIMILIAN BRIDGE FAILURE in Munich recommends that the arches be not taken down, as it is concluded that they were damaged but little by the slipping of their hinges (for a description of the accident see Eng. News of Oct. 27, 1904). It is advised that the hinges be secured in their present position and the structure left without attempting to restore it to its original condition.

THE EXHIBITION OF RAILWAY APPLIANCES to be held in connection with the International Railway Congress at Washington in May was approved by the House of Representatives on Jan. 9, by the passage of a joint resolution granting permission for the use of the tract of ground desired near the Washington Monument.

THE N. Y. BARGE CANAL CONTRACTS are being held up pending a decision of the Attorney-General on two points of law. It has been questioned whether, under the act governing the proposed work, bidders could submit both lump sum and itemized bids on the same contract. The opponents of the canal have also questioned the constitutionality of the Barge Canal act. This last question appears to rest upon the right to abandon or sell any part of the old Erie Canal, which, according to the State Constitution, must be held forever. In view of the fact that the present Erie Canal does not always follow the route of the original Erie Canal, and that many abandoned stretches of the old canal exist, there does not appear to be much weight in the argument that to abandon a part of the present Erie Canal for the Barge Canal would be unconstitutional.

## ENGINEERING MATERIAL PRICES.

These prices will appear in the first or second issue of each month.

TRACK FASTENINGS—
Chicago—at mill—Angle bars, 1.35 to 1.40 cts.; spikes, 1.70 to 1.75 cts.; track bolts, 2.30 to 2.45 cts.

RAILS, STEEL—
New York—at mill—New standard sections, $28; light rails, 24.50 to $25; old iron, f. o. b. New York, $20.50 to $21.50; old steel, rerolling lengths, $17 to $17.50; old steel, short pieces, $16 to $16.50; relayers, $20 to $21.
Chicago—at mills—New, $28, standard sections; light rails, $24 to $30; old iron, $21.50 to $22; old steel, 4 ft. and over, $16 to $16.50; old steel, less than 4 ft., $15.50 to $16; heavy relayers, $22.50 to $23; heavy relayers for side tracks, $20 to $20.50.
Pittsburg—at mill—Standard sections, $28.

STRUCTURAL MATERIALS—
New York—at tidewater—Beams, channels, angles and zees, 1.64½ to 1.80 cts.; tees, 1.69½ to 1.80 cts.; bulb, angles and deck beams, 1.74½ to 1.85 cts.
Chicago—I-Beams and channels, 3 to 15-in., inclusive, and angles 3 to 6-in., ¼-in. and heavier, 1.66½ cts.; tees, 3-in. and over, 1.71½ cts. Store prices, angles, beams and channels, 1.90 cts.
Pittsburg—Beams and channels, up to 15-in., 1.50 cts.; over 15-in., 1.60 cts.; angles, 3 × 2 × ¼-in. thick up to 6 × 6-in., 1.50 cts.; angles, 8 × 8 and 7 × 3½ ins., 1.60 cts.; zees, 3-in. and larger, 1.50 cts.; tees, 3-in. and larger, 1.55 cts.

PLATES AND SHEETS—
New York—at tidewater—Sheared plates, carload lots, tank, 1.64½ to 1.75 cts.; flange, 1.74½ to 1.90 cts.; marine, 1.84½ to 2 cts.; fire box, 1.84½ to 2.50 cts.
Pittsburg—Tank, ¼-in. thick 6¼ to 24-in. wide, 1.40 cts. at mill, Pittsburg; flange and boiler steel, 1.50 cts.; marine and ordinary fire box, 1.60 cts., at mill, Pittsburg; locomotive fire box, 1.90 cts.

MERCHANT STEEL—
Chicago—Machinery, smooth finished, 1.81½ cts.; tire, smooth finished, 1.76½ cts.; railway spring, 1.76½ cts.; crucible tool, 6½ to 8 cts.; special tool, 13 cts. and up.
Pittsburg—Open hearth spring steel, 2 to 2.10 cts.; tire steel, 1.60 to 1.65 cts.; smooth finished machinery steel, 1.60 cts.; toe calk steel, 1.95 to 2 cts.

IRON—
Pig Iron:
New York—No. 1 X Foundry, $17.25 to $17.75; No. 2 X Foundry, $17 to $17.50; No. 2 Plain, $16.50 to $16.75; Gray Forge, $16 to $16.50; Southern No. 1 Foundry, $17.25 to $17.75.
Chicago—f. o. b., Chicago.—Lake Superior charcoal, $18.50 to $19; Northern Coke Foundry, No. 1, $18; Northern Coke Foundry, No. 2, $17.50; Northern Coke Foundry, No 3, $17; Northern Scotch, No. 1, $18 to $18.50; Ohio Strong Softeners, No. 1, $19.30 to $19.80; Ohio Strong Softeners, No. 2, $18.80 to $19.30; Southern Silvery, 4 to 6% Silicon, $18.65 to $19.65; Southern Coke, No. 1, $17.65; Southern Coke, No. 2, $17.15; Souther nCoke, No. 3, $16.65; Southern Coke, No. 4, $16.40; Southern Coke, No. 1, Soft, $17.65; Southern Coke, No. 2, Soft, $17.15; Southern Gray Forge, $16.50; Southern Mottled and White, $15.90; Malleable Bessemer, $17.50; Standard Bessemer, $18.50 to $19; Jackson County and Kentucky Silvery, 6 to 8% silicon, $21.30 to $22.30; Jackson County and Kentucky Silvery, 10% Silicon, $23.30; Alabama Basic, $17.15; Virginia Basic, $17.15.
Pittsburg—Bessemer at Valley furnace, $16 to $16.25; Foundry iron, Northern No. 2, $16.50, at furnace; Northern forge, $15 to $15.50 at Valley furnace.
Cast-Iron Pipe:
New York—Carload lots, net tons, 6 to 10 ins., at tidewater, $26.50.
Chicago—4-in. water pipe, $28.50; 6-in. and heavier, $27.50 with $1 extra for gas pipe.

MISCELLANEOUS MATERIALS—
Asphaltum:
Ventura and other California asphalts, $20 to $21 per ton at New York; Trinidad refined, $25 to $30 per ton; Venezuela asphalt, $25 to $30 per ton.
Cement:
Rosendale, in wood, $1; Portland, domestic, $1.70 to $1.80; Foreign brands, $2.25 to $2.50.
Copper:
Lake, 15.12½ to 15.37½ cts.; electrolytic, 15 to 15.25 cts.; casting, 14.75 to 15 cts.
Lead:
New York, spot, 4.60 to 4.70 cts.
Spelter:
New York, spot, 6.15 to 6.25.
Tin:
New York, spot, 28.95 to 29.15 cts.

LUMBER—
New York, wholesale prices:
Piling—Spruce, ordinary cargoes, 5 to 6 cts.; oak, 14-in. butt, 40 to 50 ft., 19 cts.; 50 to 55 ft., 22 cts.; 55 to 60 ft., 23 cts.; 60 ft. and up, 25 cts.; pine, 60 to 65 ft. $8.50; 65 to 70 ft., $9.50; 70 to 75 ft., $10.50; 80 ft. and up, $16.
Railroad ties—Yellow pine, 6 × 9 ins. × 8 ft., 58 to 60 cts.; 6 × 8 ins. × 8 ft., 53 to 55 cts.; 7 × 9 ins. × 8 ft., 62 to 64 cts.; 7 × 8 ins. × 8½ ft., 57 to 59 cts.; 7 × 9 ins. × 8½ ft., 64 to 66 cts.

## PERSONAL.

Mr. Frank P. Cobb has been reappointed City Engineer of Chicopee, Mass.

Mr. Edward J. Johnson has been appointed City Engineer of Nashua, N. H.

Mr. Ovid F. Winslow has been elected Superintendent of Streets of Nashua, N. H.

Mr. W. H. Luster, Jr., M. Am. Soc. C. E., has been re-elected a City Surveyor of Elizabeth, N. J.

Mr. W. Pierrepont White has been appointed Superintendent of Roads of Oneida County, New York.

Mr. Murray McMillin, Superintendent of Water-Works Department of Marietta, O., has tendered his resignation.

Mr. Arthur Pew, M. Am. Soc. C. E., has opened an office at 619 Temple Court, Atlanta, Ga., for the practice of Civil Engineering.

Mr. Edwin H. Smith, formerly Engineer for Southern Ohio Lighting & Power Co., has been appointed City Civil Engineer of Zanesville, O.

Mr. Henry W. Warner has been appointed Superintendent of the municipal electric light plant of Muncie, Ind., to succeed his brother, Mr. W. F. Warner, resigned.

Mr. J. T. Norton, M. Am. Soc. C. E., has been appointed Secretary-Treasurer and Assistant Engineer of the Public Belt Railway Commission of the City of New Orleans, La.

Mr. James B. Greer has left the employ of the Pittsburg Filter Manufacturing Co., of Pittsburg, Pa., and is now connected with the Greer Filter Co., of Philadelphia, Pa.

Mr. G. B. Huske has been appointed Assistant Engineer of Roadway of the Atlantic Coast Line R. R., to succeed Mr. W. G. Furlong, who has been assigned to other duties.

Mr. D. W. Pike has resigned his position as City Engineer of Kansas City, Mo., and Mr. E. W. Harper, for ten years Chief Draftsman in the City Engineers' Department, has been selected to succeed him.

Mr. W. J. Mozart of East Boston, Mass., sailed from San Francisco, Cal., Jan. 10, for Cebu, Philippine Islands, where he is to act as Superintendent of Harbor Construction for J. G. White Co., Contractors.

Mr. F. A. Delano, General Manager of the Chicago, Burlington & Quincy Ry, has resigned his position, which he has held for three years, after having held a number of other positions with the same road.

Mr. H. Rohwer, M. Am. Soc. C. E., heretofore Chief Engineer of the Missouri Pacific Ry., has been appointed Consulting Engineer of that system, with headquarters at St. Louis, Mo., to succeed Mr. J. W. Way.

Mr. E. J. Williams, for the past 18 years Manager of Branch Houses and Department Manager of the Austin Manufacturing Co., has tendered his resignation to that company and will take charge of the Williams Contractor's Supply Co. of Columbus, O.

Mr. Webster Gazley has resigned his position as Assistant Engineer of the Louisville Water Co., to become Chief Engineer and Vice-President of the National Concrete Construction Co., of Louisville, Ky. Mr. Gazley had been connected with the water company for 17 years.

Mr. Walter G. Kirkpatrick, M. Am. Soc. C. E., for the past seven years City Engineer of Jackson, Miss., has resigned that position and will devote his entire time to his private practice, as a member of the firm of Kirkpatrick & Johnson, Civil and Mechanical Engineers, Jackson, Miss.

Mr. D. F. Maroney has left the service of the Pittsburg, Shawmut & Northern R. R. Co., the office of Vice-President in charge of operation and traffic, heretofore held by him, having been abolished. The duties hitherto performed by Mr. Maroney will be assumed by the Acting President.

Mr. J. H. Inquinton, of the United States Reclamation Service, has been detailed to act as Supervising Engineer for Colorado, Nebraska and the North Platte River basin. He will have general charge of all government irrigation work in that district. He will make his headquarters at Denver, Colo.

Mr. C. E. Fowler, M. Am. Soc. C. E., has resigned as President of the Puget Sound Bridge & Dredging Co. of Seattle, Wash., and has formed the International Contract Co., of which he will be President and Chief Engineer. The new company will handle bridges, foundations, and river and harbor improvements.

Mr. C. W. Raynor, Assoc. M. Am. Soc. C. E., has resigned his position as First Assistant Engineer of The Midland Bridge Co., of Kansas City, Mo., to become associated with Mr. H. H. Hahn and Mr. H. N. Barr under the name of The Western Engineering Co., with offices at 407-408 Jackson Building, Denver, Colo.

Mr. Louis H. Barker, heretofore Principal Assistant Engineer of the United Railroad of New Jersey, with headquarters at Jersey City, N. J., has been appointed to the newly created position of Assistant Chief Engineer of the Pennsylvania R. R., with headquarters at Philadelphia, Pa. Mr. E. B. Temple has been appointed Assistant to the Chief Engineer.

Mr. Max J. Unkelbach for the past 12 years Principal Assistant to Engineer W. H. Cadwell of the Sewer Board of New Britain, Conn., has resigned that position and has opened an office as Architect and Civil Engineer at 319 Main St., New Britain, Conn. For the last two years Mr. Unkelbach has been in charge of the construction of the filter beds and trunk sewer at New Britain.

Mr. Charles S. Treadway, has been compelled to resign as President and Treasurer of the Bristol Water Co. of Bristol, Conn., on account of ill health. Mr. William B. Sessions succeeds him as President and Mr. Morris L. Tiffany is his successor as Treasurer. Mr. Treadway had been active manager of the company for about 20 years, and with his resignation, a new office was created, that of General Manager, this being filled by the selection of Mr. Charles L. Wooding.

Mr. Edmund F. Van Hoesen, M. Am. Soc. C. E., has been appointed Deputy New York State Engineer and Surveyor to succeed Mr. William P. Judson, M. Am. Soc. C. E., whose resignation of that position was mentioned in these columns last week. Mr. Van Hoesen was connected with the Pennsylvania R. R. Co., from 1879 to 1886 and from that year to the present time he has been in the employ of the New York Central & Hudson River R. R. Co., his latest position being that of Resident Engineer of the Western District, with headquarters at Buffalo, N. Y. He is a Director of the American Society of Civil Engineers.

Mr. E. D. Leavitt, M. Am. Soc. M. E., was recently presented with a handsome silver service by some of his former associates. Mr. Leavitt for many years has had his offices as Mechanical and Consulting Engineer in Central Sq., Cambridge, Mass., and he lately relinquished these in giving up some of the greater activities in which he had been engaged. In recognition of this 38 men who in the past had been in Mr. Leavitt's offices gave him the gift. The service bore the following inscription:

Presented
to
Erasmus Darwin Leavitt
By his draughtsmen,
In grateful appreciation of
the sound engineering training
given by him
during thirty years.

The engineers of the Reclamation Service of the U. S. Geological Survey, held the second annual conference at Washington, D. C., last week for the discussion of subjects in connection with the work of the service. The following is a list of the members of the Reclamation Service who were in attendance at the conference: Cyrus C. Babb, District Engineer for Montana; S. K. Baker, Hydrographic Aid, Washington; H. K. Barrows, Engineer in charge of hydrographic investigations in New England; Morris Bien, Engineer and legal adviser; C. J. Blanchard, Statistician; George N. Bliss, Assistant Engineer, Washington; R. E. Bolster, Assistant Engineer, Washington; L. V. Branch, Assistant Engineer, North Platte project; W. W. Burnham, Hydrographic Aid, Washington; F. H. Cass, Traffic Agent; S. K. Clapp, Assistant Engineer, New England; C. C. Covert, Assistant Engineer, Hydrography, New York and Michigan; N. H. Darton, Geologist, in charge investigation of underground waters in western section; A. P. Davis, Assistant Chief Engineer; A. L. Fellows, District Engineer for Colorado; J. E. Field, Engineer in charge of North Platte project; Chas. Fitch, Chief Auditor of Reclamation Service and Supervising Engineer for South Dakota; Robt. Follansbee, Assistant Engineer, Washington; M. L. Fuller, Geologist in charge of eastern division of Hydrology; J. H. Giles, Assistant Engineer southern stream measurement; N. C. Grover, charge

stream measurement, Washington District; M. R. Hall, charge southern section hydrography; W. E. Hall, Assistant Engineer, southern section hydrography; F. W. Hanna, Assistant Engineer, Washington; G. F. Harley, Engineering Aid, Washington; R. W. Hawley, Assistant Engineer, Washington; L. C. Hill, Supervising Engineer for Arizona; A. H. Norton, Engineer, Washington; R. E. Horton, charge hydrographic investigations, New York and Michigan; J. C. Hoyt, Computer, stream gaging work; Edw. J. Johnson, Engineer in charge of hydrographic investigations in Mississippi District; A. E. Kastl, Constructing Engineer; M. O. Leighton Hydrographer, in charge of Hydro-economics; S. J. Lewis, Assistant Engineer, Washington; H. V. Lemenarger, Draftsman, Washington; J. E. Lippincott, Supervising Engineer for California; I. W. McConnell, Engineer in charge Uncompahgre Valley project; Thos. H. Means, Engineer of Soils, charge of land classification; E. C. Murphy, Engineer, Inspector of Stream Gaging; F. H. Newell, Chief Engineer; T. A. Noble, District Engineer for Washington; C. R. Olberg, Assistant Engineer, Washington; H. N. Parker, Assistant Hydrographer, Washington; E. G. Paul, Engineer, Washington; E. T. Perkins, Engineer, travelling auditor; F. E. Pressey, Engineer, Assistant New England stream gaging; C. T. Prall, Assistant, Milk River project; J. H. Quinton, Consulting Engineer; G. B. Richardson, Assistant Geologist; D. W. Ross, District Engineer for Idaho; W. H. Sanders, Consulting Engineer; H. N. Savage, Supervising Engineer, Montana and Wyoming; W. W. Schlecht, Assistant Engineer; Chas. S. Slichter, Engineer, in charge of investigation of movement of underground waters; Herman Stabler, Engineering Aid; W. O. Steward, Washington; H. A. Storrs, Electrical Engineer, in charge of pumping projects in North Dakota; L. H. Taylor, Supervising Engineer for Nevada; T. U. Taylor, Engineer, stream measurements in Texas; F. H. Tillinghast, Assistant Engineer; R. F. Walter, District Engineer, South Dakota; N. E. Webster, Bookkeeper, Reclamation Service; T. B. White, Washington.

## Obituary.

Augustus Joslin, formerly Superintendent of Waterworks of Norwalk, O., died in that city, Jan. 8, aged 80 years.

Henry Summerfield Beard, Secretary of the Beard Dredging Co., died at his home in Brooklyn, N. Y., Jan. 6. He was 30 years old.

Julius S. Munckwitz for 15 years an Architect of the Park Department of New York, died of heart disease at his home in that city Jan. 4.

Charles G. Williams, of Norwalk, O., who had charge of the building of the Phoenix Globe Arizona Irrigation Canal, died at Phoenix, Ariz., Jan. 10, aged 34 years. Mr. Williams was formerly connected with the Massachusetts Highway Commission.

John T. Farley, of the firm of John T. & James A. Farley, builders, died of heart disease, at his home in New York City, Jan. 4. During the last six or seven years Mr. Farley has erected many of the finest houses in the Fifth Ave. section of New York.

C. M. Wilkes, Engineer in charge of the mechanical work of D. H. Burnham & Co., Architects, of Chicago, Ill., died suddenly, Jan. 7, at a hotel in Philadelphia, Pa., where he had gone to direct the work of his firm on a large department store building. Mr. Wilkes' body was taken to Joliet, Ill.

Charles H. Souther, President of the New England Dredging Co. since its formation in 1873, died at his home in Jamaica Plain, Mass., Jan. 4. Mr. Souther's work had been connected largely with the dredging of Boston Harbor, the filling in of the South Boston flats and the building of the Charles River embankment. He was 55 years old.

Henry B. Looker, Surveyor of the District of Columbia, died in Washington, D. C., Jan. 3, aged 47 years. Mr. Looker had been District Surveyor continuously since Aug. 18, 1897, except during the time of the Spanish-American War, when he served in Porto Rico as Captain of Company H of the District Volunteers, which acted as a volunteer engineer organization.

Dr. Benjamin W. Frazier, M. Am. Inst. Min. Engrs., Professor of Mineralogy and Metallurgy at Lehigh University, since 1871, died at his home in Bethlehem, Pa., Jan. 4, of apoplexy. Dr. Frazier was born in Philadelphia, in 1841, and was graduated from the University of Pennsylvania in 1859. He secured the degree of Master of Arts from that institution in 1862, and in 1899 the degree of Doctor of Science was conferred upon him. From 1866 to 1868 he was a student at the Ecole des Mines, Paris, and during 1868-69 he was at Bergakademic, Freiburg, Saxony. In addition to being a member of the Institute of Mining Engineers, Dr. Frazier was a member of the American Philosophical Society, the Academy Natural Sciences of Philadelphia, American Society for advancement of Science and the Franklin Institute. His wife survives him.

Henry Varnum Poor, who died on Wednesday, Jan. 4, 1905, was born in Andover, Oxford County, Maine, Dec. 8, 1812, and was graduated from Bowdoin College in the class of 1835, subsequently being admitted to the bar of his native State. His law practice occupied his attention until 1848, when he went to New York City, where, in 1849, he became the editor of "The American Railroad Journal," the first and, at that time, the only publication devoted to railroad affairs, issued in the United States. While still editor of "The Railroad Journal" he planned and, with the assistance of Dr. Richard Swainson Fisher, undertook the publication of what was projected to be the most elaborate work of its kind ever attempted in this country, in respect to the progress of its internal improvements, the "History of the Railroads and Canals of the United States of America, exhibiting their Progress, Cost, Revenues, Expenditures and Present Condition."

This work, stupendous at the period, was to appear in three volumes, but Vol. I., embracing in 612 pp. the railroads of the New England and Middle States, which was published in 1860, marked the full extent of the completion of the enterprise, the outbreak of the Civil War interfering with the fulfillment of the project. Shortly after this Mr. Poor retired from the "Railroad Journal," but in 1867 re-entered the field of Railway Economics, and began preparations for the publication of the first number of the Manual of the Railroads of the United States, having associated with him in this new enterprise, his son Henry William, under the firm name of H. V. & H. W. Poor, with offices at 57 and later at 68 Broadway, New York City.

Mr. Poor's position in railway affairs was unique. His youth and early manhood having been contemporary with the early development of canal building and railroad transportation, he speedily became interested in all projects that promised to assist in the more rapid development of the eastern country, and in natural order to all propositions for the opening up of the western country. In this way he became associated, in 1864, with Gen. John A. Dix, Thomas C. Durant, Geo. Opdyke, Geo. T. M. Davis, A. G. Jurome, J. F. D. Lanier, William B. Ogden, H. S. McComb and others in the organization of the Union Pacific Railroad Co., of which Mr. Poor was the first Secretary.

Mr. Poor was a forceful, and, when occasion required it, a trenchant, writer on all subjects that engaged his attention, but particularly so when those subjects concerned the financial and economic problems of the day. His most important work, "Money; Its Laws and History" attracted world-wide attention because of the independence of thought it displayed and the keenness of his shafts roused the ire of many who of those who worshipped at the altars of earlier publicists. Besides this, Mr. Poor was the author of many books covering a wide range of economic subjects, such as the Silver Question, Resumption, Protection, The Tariff, Railroad law and legislation, etc.

While an enthusiastic believer in the general principle of protection, Mr. Poor was nevertheless opposed to the levying of whatever he considered to be unjust taxation that became a burden to one important industry for the benefit of one of less magnitude, and in consonance with his principles and belief, he was the most important figure, in 1880, in the effort then made to secure a reduction, by Congress, of the duty on steel rails, which at that time amounted to what is about the selling price to-day.

Mr. Poor was a consistent and stalwart opponent of demagogism as directed against railway capital and enterprise, but never an apologist for railway rapacity or dishonest methods of railway financiering. His notes of warning, though not always heeded at the time delivered, are fruitful evidences of his farsightedness.

At the time of his death, Mr. Poor was not only the oldest living graduate of Bowdoin College, but, also, the only surviving charter member of the American Geographical Society, which recently celebrated the fiftieth anniversary of its incorporation. For a number of years past Mr. Poor had not been actively engaged in business, spending his winters in Brookline, Mass., and his summers in Andover, Me., his birthplace, and devoting his leisure to his favorite occupation, his books and writing. Shortly before his death he had under advisement the preparation of a paper on the development of railroad, canal and river transportation, to be read at the forthcoming meeting of the International Railway Association, in Washington, a subject that he was pre-eminently fitted to discuss.

Mr. Poor is survived by his wife and son, Henry W., of the firm of H. W. Poor & Co., bankers, New York and Boston, and by three daughters.

For the above obituary notice we are indebted to the kindness of Mr. Jno. P. Meany, Treasurer and Manager of Poors Railroad Manual Co.

## ENGINEERING SOCIETIES.

### COMING MEETINGS.

INDIANA ENGINEERING SOCIETY.
Jan. 12 to 14, 1905. Annual meeting at Indianapolis. Secy., C. C. Brown, Commercial Club Bldg., Indianapolis, Ind.

WOOD PRESERVERS' ASSOCIATION.
Jan. 16 to 19, 1905. First annual meeting at New Orleans, La. Secy., C. W. Berry, Laramie, Wyo.

NATIONAL ASSOCIATION OF CEMENT USERS.
Jan. 17 to 19, 1905. Annual convention at Indianapolis, Ind. Secy., C. C. Brown, Indianapolis, Ind.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 18 and 19, 1905. Annual meeting at New York, N. Y. Secy., C. W. Hunt, 220 W. 57th St., New York.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 18 to 20, 1905. Annual meeting at Chicago. Secy., E. R. R. Tratman, 1636 Monadnock Block, Chicago, Ill.

OHIO SOCIETY OF SURVEYORS AND CIVIL ENGINEERS.
Jan. 23 to 25, 1905. Annual meeting at Columbus, O. Secy., E. G. Bradbury, Columbus, O.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 24 to 26, 1905. Annual meeting at Montreal, P. Q. Secy., Prof. C. H. McLeod, 877 Dorchester St., Montreal, P. Q.

STATE AND LOCAL BOARDS OF HEALTH OF OHIO.
Jan. 27, 28, 1905. Annual meeting at Columbus, O.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Jan. 30 to Feb. 11, 1905. Annual meeting at Birmingham, Ala.

ASSOCIATION OF ONTARIO LAND SURVEYORS.
Feb. 28, 1905. Annual meeting at Toronto, Ont. Secy., Killaly Gamble, Temple Bldg., Toronto.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—The annual meeting of the society was held at its quarters, 410 Penn Ave., Pittsburg, on Thursday, Jan. 5. The election of officers for 1905 gave the following result: President, Mr. S. Diescher; Vice-President, Mr. S. M. Kintner; Secretary, Mr. F. V. McMullin; Treasurer, Mr. A. E. Frost; Directors, Messrs. G. T. Barnsley and Morris Knowles.

WESTERN SOCIETY OF ENGINEERS.—The annual meeting and banquet were held at the Auditorium Hotel, Chicago, Jan. 3. The secretary's report showed the following: Number of members, 812; expenditures, $10,431; receipts, $11,080; balance in bank, $2,758. The officers for the present year are as follows: President, Edward C. Carter, Chief Engineer of the Chicago & Northwestern Ry.; Vice-Presidents, G. A. M. Liljencrantz, Charles F. Loweth and L. P. Breckenridge; Treasurer, Andrews Allen; Secretary, J. H. Warder.

OHIO SOCIETY OF CIVIL ENGINEERS AND SURVEYORS.—The headquarters during the annual meeting of the society, Jan. 23 to 25, will be at the Great Southern Hotel, Columbus, O. The program will include papers on the Cooperative Topographical Survey, by Prof. C. E. Sherman; on Sewage and Garbage Disposal, by Mr. F. A. Barbour and Mr. W. F. Morse, on the Ohio canal system, by Mr. C. E. Perkins; on the work of the Geological Survey in stream gaging, by Mr. R. W. Pratt, and other papers. A number of committee reports will also be presented, covering the subjects Legislation, Highways, Civil Engineering, Drainage, Land Surveying, Office Records, Registration of Civil Engineers and Surveyors, etc. One or more excursions, and a social session, will be features of the meeting.

OHIO BOARDS OF HEALTH.—The fifteenth annual meeting of the State and Local Boards of Health of Ohio will be held at Columbus, O., on Friday and Saturday, Jan. 27 and 28, 1905. Members of boards of health, inspectors, health officers, and all connected with public hygiene are invited to attend. The meeting will comprise four sessions, at 10.30 a. m., 1.45 and 7.45 p. m., Friday, and 9 a. m., Saturday. They will be held in the Board of Trade Auditorium, on Broad St. The following papers are to be read: "The Laboratory in the Diagnosis of Diphtheria," by Mr. E. G. Horton, of Columbus; "Quarantine of Observation in the Prevention of Smallpox," by Dr. H. M. Platter, of Columbus; "The Sewage Testing Station at Columbus," by Mr. G. A. Johnson, of Columbus; "Filtration of Public Water Supplies," by Mr. R. W. Pratt, of Columbus; "The Relation of the Medical Profession to the Restriction of Tuberculosis," by Dr. S. P. Wise, of Millersburg; "Disposal of Garbage and Refuse," by Mr. W. F. Morse, of New York, N. Y.; "Conflict Among Legislative Bodies a Hindrance to Sanitation," by Dr. M. Millikin, of Hamilton; "The Sanitary Organization of 1950," by Dr. J. W. Clemmer, of Columbus; "Should We Have County Health Officers," by Dr. F. E. Kitzmiller, of Piqua.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the regular meeting of Wednesday, Jan. 4, 1905, held at the society's house, 220 West 57th St., New York, a paper on "Methods of Location on the Choctaw, Oklahoma & Gulf R. R." was read by Mr. F. Lavis. The paper is a very detailed description of the makeup and equipment of a locating party, for preliminary and final locating work, and of the conduct of their work. Itemized lists of equipment and food supplies, specimens of reconnoissance notes, survey notes, profiles and location maps, bridge data, cost tables, etc., accompanied the text. The paper contains a great amount of record information of interest, but it is impracticable here to give more than the above suggestion of its contents. In discussion, Mr. E. Sherman Gould strongly advocated a field revision of the final location, in supplement to the map location which the author seems to prefer for the final determination. Mr. Gould criticized the use of German Silver for tableware in camp, and criticized the form of field notes used in the surveys described by the author.

The annual meeting of the society will open at 10 a. m., Jan. 18, 1905, at the society's house, and will continue through Jan. 18 and 19. The annual reports will be presented, officers elected, and members of the nominating committee appointed.

# ENGINEERING LITERATURE

Supplement to ENGINEERING NEWS. New York, January 12, 1905.

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A biographical directory, to be called "American Engineers," is proposed by Mr. E. C. Brown, of New York City, who is well known among gas men as the publisher of the "Progressive Age," and of Brown's "Directory of American Gas Companies." About 3,000 names will be selected for inclusion, mostly from active members of ten years' standing in the civil, mechanical, electrical, mining, naval and chemical engineering societies. The information given will include, among other facts, statements regarding the education and the successive professional engagements of each engineer, his membership in technical societies and clubs, the books, papers and articles which he has written and his present occupation.

A satisfactory biographical directory of engineers would doubtless be well received and the plan as outlined, although more restricted in scope than some would like to see, has much to commend it. From the biographical point of view perhaps 3,000 names are all that would be warranted in a first edition, but looked upon as a directory of engineers obviously that number is very inadequate. Why not supplement the biographical section with a directory pure and simple, including at least every engineer in the six societies named? Such a directory should be arranged geographically and the abbreviations C., Mi., E., Mg., N. and Ch. could be used to denote membership in one or more of the six societies named above.

The question has been raised whether the term "cast steel" is desirable or permissible under modern conditions. The case refers, of course, to articles of mild steel cast in molds directly to the required shape. The material in such articles is almost absolutely identical with the material in boiler plates or structural shapes. It has good ductility, high elastic limit, a definite yield-point, and excellent impact-test properties. Shall such material be called "cast steel," or shall this term be sedulously avoided? If the term "cast steel" is not to be used, then what other term may we use?

We have repeatedly heard emphatic argument against the use of "cast steel" to denote the material in mild steel castings. The argument premised that the old term "cast steel" denoted crucible steel in general, and usually connoted a very inferior metal—brittle, non-homogeneous, and difficult to work. The argument then was: The modern mild steel casting contains a material altogether different from the old cast steel, and it is proper, in order to differentiate the two as clearly as possible, that it should have a name of its own. The excellent steel casting should not suffer by an implication of the bad qualities of "cast steel."

On the other side is a defensive argument. The article is of steel, and it is cast, hence it is rightly called a cast steel pedestal or bolster or whatever the article may be. Moreover, there is no convenient term to substitute. When we speak of a certain gear-wheel, and wish to state the material at the same time as the purpose, it is natural to say "Cast Steel Gear Wheel," and no other term is available.

We refer the question to our readers. First, is there good reason for avoiding the use of "cast steel" in speaking of mild steel castings? Second, if so, what other and better term can be substituted?

Why does one important branch of engineering, that pertaining to gas for light, heat and power, lack an American literature in book form? Under the title "Books on Gas," "The Progressive Age" (New York, Dec. 1) opens an editorial as follows:

> There is a good demand here for books published in England of interest to the gas man, not because of superior quality but because there are practically no books upon gas works engineering published in this country relating to our conditions and by American authors. The unthinking ask why this is so and declaim against it but are the first to pass by on the other side when asked to subscribe for such a book. In fact the want is not as real as it seems. If it would show promises of being remunerative, we, as publishers, would already have a list of American gas books to offer, but there seems to be no good reason why we should issue such books at a loss.

It would be interesting to know why gas engineers and superintendents do not demand American books on gas engineering; or if our contemporary is mistaken as to there not being sufficient demand to make such books remunerative then it would be equally interesting to know why they are not written. From the inquiries for books on gas engineering that reach us we are convinced that a thoroughly practical well-written American treatise on the subject would be at least a moderate financial success. Is it not true that until quite recently the whole gas business in America, engineering and all, has been conducted more like a close corporation or medieval guild than has almost any other technical industry engaged in supplying municipal needs? We think it is true and that this largely explains the lack of an American gas literature. The extension of the use of gas both for domestic and manufacturing purposes and the entrance of new blood into the gas profession, young men with broader engineering training, will doubtless contribute to an increased demand for American books on gas engineering and at the same time produce men able and willing to write such books. Fortunes cannot be expected in this more than in other branches of engineering literature, but the man who produces the first good American gas book will certainly have a full measure of the reward with which most writers in other fields of engineering literature have to be content, namely the satisfaction of having produced a book greatly needed by fellow-engineers.

It is frequently assumed by writers of engineering books that some phases of their subjects are so simple as to require little or no treatment. Perhaps this explains why water tanks of wood have been so generally ignored or overlooked by authors of books on water-works. In reviewing the first edition of Hazlehurst's "Towers and Tanks for Water-Works," some years ago, we called attention to the strange omission of wood tanks from that book. The second edition, published early this year, does not make good the deficiency. It contains a few words on wood tanks, which may have been in the first edition, but are not indexed in either edition.

In view of such an omission from a volume devoted to tanks and towers, it is not so surprising not to find the subject discussed in the general treatises on water-works by Fanning, Folwell and Goodell. Turneaure & Russell have about 200 words on wood tanks and in one of their special bibliographies, which are so commendable features of their book, they give a single reference to the general subject and three references to articles on specific tanks. The general reference is to Snow on "Steel vs. Wood Tanks" for railroad purposes (Jour. West. Soc. Engrs., 1899, p. 266). The other articles named are as follows: Wood tanks and towers at Fulda, Minn., and Scotland, Pa. (Eng. Rec., pp. 438 and 457, vol. xxxii., 1895), and a wood tank at Parkersburg, Ia. (Eng. News, vol. xxxiii., 1895, p. 34). In Engineering News of March 5, 1903, there appeared "A Stress Diagram for Wooden Tank Hoops," by Ballinger & Perot, and in the issue for April 16, following, there was a letter from Mr. Macy S. Pope which contained a diagram for a similar purpose, reproduced from the bulletin mentioned below.

Trautwine's pocket-book contains a few lines on wood tanks for railway purposes. The new edition of Kidder's pocket-book (see this Supplement for Nov. 17, 1904) contains more and better information on wood tanks in general than is given in any of the books previously mentioned. It is only fair to add that what Kidder gives is taken from a bulletin by the Inspection Department of the Factory Mutual Fire Insurance Cos. (31 Milk St., Boston, Mass.). That bulletin, so far as we know, is the best publication on the subject available in this country.

We do not claim to have exhausted the literature of wood tanks, but our search has gone far enough to show how the subject has been overlooked in a number of instances where it would not be expected. The oversight is all the more significant in view of the numerous recent failures of wood water tanks.

The proper relation between engineering education and so-called liberal education is a subject which is now being discussed from many viewpoints. At the inauguration of President Charles S. Howe as President of the Case School of Applied Science, reported in the pamphlet noticed in this Supplement for Dec. 15, 1904, a number of the speakers contributed to the discussion.

President Henry S. Pritchett, of the Massachusetts Institute of Technology, said:

> Perhaps it is not so easy to say what constitutes a liberal education, because education consists of so many factors drawn from so many sources; but a liberal profession is one in which those belonging to it know enough of outside professions and of general human knowledge to respect and to appreciate the work of other men, and the practical question in the education of the engineer is, shall he have such an education as will give him this respect for and this appreciation of other professions and of other men.

Another and an eminently practical phase of the subject may next be presented in the form of a quotation from the address of Mr. John R. Freeman:

> Within the past week I have chanced to hear two heads of great concerns each employing many scientific men, say in substance that the old academic education fits better for the position where one deals with men, or for the $10,000 position, while the technical school fits better for the position that deals with materials, or for the $4,000 position, and I note that sons of my old classmates are being sent first to Harvard or Yale or Dartmouth for four years and then to "Technology" for a two-years' course in science.

Answering the objection that six years is more time than the average boy can afford to give to school work, Mr. Freeman said:

> When we more fully appreciate that education, rather than information, is the true aim of the technical school,

then a broad education and sufficient information can both be given in a four years' course.

Can we not give a better education to the great majority of our students and plant in them thirst for information by doing fewer things more profoundly and putting more emphasis on the personal element.

**The subject of President Howe's inaugural address was "Does a Technical College Educate?" As a definition of a liberal education he quoted, as appealing to scientific minds, the following from Huxley:**

That man, I think, has a liberal education, whose body has been so trained in youth that it is the ready servant of his will, and does with ease and pleasure all that, as a mechanism, it is capable of; whose intellect is a clear, cold, logic engine, with all its parts of equal strength and in smooth running order, ready, like a steam engine, to be turned to any kind of work and to spin the gossamers as well as forge the anchors of the mind; whose mind is stored with the knowledge of the great fundamental truths of nature and the laws of her operations; one who, no stunted ascetic, is full of life and fire, but whose passions have been trained to come to heel by a vigorous will, the servant of a tender conscience; one who has learned to love all beauty, whether of nature or of art, to hate all vileness, and to esteem others as himself.

**We present these quotations to our readers without further comment than an expression of general approval.**

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**A thoroughly satisfactory literature on ventilation does not seem to be more abundant in Great Britain than America. In a paper on "Ventilation of Buildings," read before the Architectural Association on Nov. 11, Mr. W. Henman, F. R. I. B. A., said:**

Perhaps the most unfortunate circumstance in connection with ventilation results from the fact that eminent early writers thereon, whose works are still largely resorted to, make assertions from their undoubtedly careful observations which, in face of more modern practice and the great improvements which have since been effected in appliances, cannot now be accepted. One of the best standard works is that by Dr. D. B. Reid, who for some years supervised the ventilation of the Houses of Parliament. He published in 1844 a book entitled "Illustrations of Ventilation." His observations and general statements are generally trustworthy, but his deductions are sometimes at fault. A more modern book is that of Dr. J. S. Billings, of the John Hopkins' Hospital fame, entitled "Ventilation and Heating," consisting of some 500 pages. It brings together a vast mass of useful information on the subject; but, being written by an American principally for use in America, a considerable portion of its contents is unsuitable for this country, and a careful perusal of the volume left on my mind a sense of indefiniteness, examples being given of so many different methods without clearly indicating those that are worthy of adoption or those that should be avoided. There are numerous other writers on different phases of the subject, but the two mentioned are, so far as I know, the only books in English which deal with it exhaustively. Yet there is in both a lack of that practical guidance based on modern experience such as architects now require. The result has been to engender what I may term a chaotic state of mind in the profession.

**The criticism of Dr. Billings' classic work is not surprising, but it should be stated that the theory of ventilation is presented by the author before he gives his numerous examples drawn from practice.** It is true that these examples come near being an embarrassment of riches, unless studied with great care, and that more extensive critical comments might have been of great service. If it were possible for so busy a man as Dr. Billings to revise his book so as to bring it quite up to date his efforts would be appreciated both at home and abroad. The last edition of "Ventilation and Heating" appeared in 1893.

Presumably Mr. Henmann has never seen Prof. R. C. Carpenter's "Heating and Ventilating Buildings," first published in 1895 and revised and enlarged in 1902. Professor Carpenter had the advantage of later information than did Dr. Billings, yet we fear that even if Dr. Billing's book be supplemented by Professor Carpenter's the "chaotic state of mind" mentioned by Mr. Henmann will still exist among members of the architectural profession. Closely associated as are heating and ventilation it might make for clearness if some well-informed person would write a brief and simple book on ventilation alone, suited to the needs of the sanitarian, the architect and the engineer.

## CORRESPONDENCE.

### Signs for Compressive and Tensile Stress.

Sir: In your issue of Dec. 15, 1904, you open a discussion as to which of the two symbols, + and —, is to be preferred for designating compressive stress. The arguments which you present pro and con are interesting, but a final decision between the two could hardly be made except upon arbitrary or whimsical grounds. Hence it looks hopeless to expect complete abandonment of either practice. Neither side will be able to see any sufficient reason for giving up its accustomed methods, and hence will not take the initiative in surrendering. While each side waits for the other to take this step, nothing will be done.

Still I agree with you that uniformity is highly desirable. No choice being likely between familiar opposing methods, the only course to take is to seek new symbols such as may be hoped to be readily acceptable to all. I think such symbols may be found in the characters C and T, for compression and tension respectively. They are of course merely the block-letter initials of the words which they designate.

These symbols offer no chance for confusion, and they are easily made. They seem to me to meet all requirements of graphic computation and particularly of stress-sheets and other exhibits of results. In algebraic computations, the + and — signs will of course be retained, and the individual computer may perfectly well be left to his own predilections or those of his office, provided only that his results for others' use are stated unmistakably. Computations would rarely be examined unless by an expert who with the aid of the context could hardly be misled. Such contextual aid is often wanting in exhibits of results.

The logical course would accordingly be:

1. On all stress-sheets and other general exhibits or statements of results (whether in drawings or in technical literature), use C for compression and T for tension.

2. In all computation work, leave individuals or individual offices to their preferences. In course of time they might come to a uniform practice, but how rapidly is of minor consequence.

Whether the proposed new symbols will most conveniently be placed before the numerals or after them may depend upon circumstances. In any case they will be intelligible and unmistakable. Probably they would best be used as prefixes just as + and — have been. Then in stress-sheets the initials of the kind of load causing the particular stress can be designated by the initial of the kind of load as a suffix, as is frequently done now. Written beside a member, a full instalment of stresses would then appear thus:

| | | |
|---|---|---|
| C 120,000 d | | T 120,000 d |
| C 240,000 l | or | T 240,000 l |
| C 180,000 l | | T 180,000 l |
| C 75,000 w | | T 75,000 w |

Possibly the lower-case letters c and t might be preferred in letter-press.

The only essential point in this suggestion is that an absolutely self-explanatory sign be used for all exhibits of results, especially where they are stated apart from their source or context. The symbols C and T, or c and t, are suggested as likely to meet all practical requirements of such signs.

L. J. Johnson, M. Am. Soc. C. E.

Harvard University, Cambridge, Mass., Dec. 23, 1904.

(We can hardly look for better testimony on the uselessness of expecting engineers to agree upon either the plus or the minus sign for compression than the above avowal of Professor Johnson that the arguments on the two sides appear to balance. A substitute notation, such as that suggested, will have a good chance for adoption provided there is a real and extensive risk of mistake in the present notations. We are not at all sure that this is the case. But if anyone who has to make stress diagrams fears the chance of misunderstandings from the plus and minus signs, there is no simpler way out of the difficulty than to adopt the C, T, prefixes suggested in this letter.

There is a close analogy to this case in the quite separate field of surveying: marking cuts and fills in earthwork. Some engineers use the signs plus and minus for this purpose, both on the stakes and in the note-book. Apparently the signs are considered as being directions to the contractor, so that fill is marked plus, in the sense of "Add the following amount." Others avoid the use of these signs, and always mark cut and fills C and F, the letter in either case being followed by the feet and tenths. Of course, the algebraic reason for using signs does not apply here as it does in the stress question, but otherwise the two cases are closely analogous.—Ed.)

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### Standard Note and Scrap Books With Interchangeable Leaves.

Sir: "Standardization" and "interchangeability" are words to conjure with, and are synonymous with convenience, order and efficiency, whether applied to the threads of a bolt or the arms and ammunition of a military establishment.

I am now endeavoring to develop and increase the value of NOTE BOOKS to engineers and students through an application of the above principles, and it is my belief that if the plan be brought to public attention, a discussion of the attendant advantages and disadvantages will take place, resulting in many new ideas and suggestions, besides developing an interest in the subject. The plan is to have all note-books of a standard size, with interchangeable pages (say, 6 × 9 ins.), held between suitable covers by means of copper fasteners passed through holes punched at the top of the sheets.

My first conception of the possibilities of this plan came while a student at Columbia University. A number of interesting and valuable drawings of some masonry work (a subject we were then studying) had been loaned me, and after reducing to suitable size, I made my copies on tracing cloth instead of, as previously, on paper. The result was, that many of my classmates soon had blue prints, which those who used note-books of the kind described were able to easily file in the proper place, while the others had to resort to mucilage; but there is soon a limit to material which can be thus pasted in and stowed away; the effect is scrappy; besides, it is difficult to remove obsolete material.

If the different college professors would insist on their students using note-books of standard size, would issue their problems, lectures and notes typewritten or mimeographed on the regulation size sheets, and would require answers and reports to be handed in, so that, after being corrected, the scholar could file them away for reference, great good would result. I have seen men throw away and lose much valuable stuff because it was not in convenient shape for use or storage.

But there is still another, and perhaps even more valuable, side to the subject. At present most all text-books are written by college professors or consulting engineers, men of broad experience, but the nature of whose work often keeps them from specializing in the different branches of any one subject, and who, therefore, are not as familiar with the details of the latest improvements as the engineers who are retained by the different manufacturing concerns to make a specialty of some one branch, be it pumps, turbines, lubricants or paints. This is the reason that trade publications are of such value; but the facts, notes, suggestions, and tables developed by the expert of the company are often so submerged by photographs of factories in which their machinery is used, or by lists of purchasers, that the pamphlet is bulky and almost useless. I have suggested to and convinced the advertising departments of many companies that if the technical schools throughout the country adopt a standard note-book for all their classes, it would be well worth the department's time to get up leaflets to fit. By this I do not mean that the water-wheel people shall try and convince us that wheels are better than turbines, even for low heads, or that the concrete pile man shall maintain that his device should everywhere supersede the timber pile; but let each describe his machine, process or product, and, stating its possibilities and limitations, give in a scientific manner notes relating to its capacity, erection, maintenance and cost, if it be a machine, or suggestions as to tests for quality, method of storage, use, or application, if it be of the nature of a cement or paint. Such leaflets would increase the prestige of the people issuing them, would be cheaper than the present form of circulars, and easier to revise, besides being in great demand, not only by college students, as above suggested, but by men in the field, for the leaflets would be easy to file, index and carry about.

A note-book should be a man's most valuable possession, because he is particularly familiar with its contents, has heard them discussed in the lecture room, or has gathered them from his own experience. Text-books soon tend to become obsolete. On the other hand, the technical journals, thoroughly abreast of the times in all matters, and as necessary to an engineer's existence as the air he breathes, present articles on any one subject scattered through so many different issues that it is sometimes hard to find them when wanted, and since the title of an article, as found in an index, gives but scant information as to its worth or scope, it is an excellent habit, aside from the thoroughness which it develops, to take notes and make comments on all articles read. These observations, when made in the note-book corresponding to the subject, give one in condensed and accessible form a resumé of the latest advances, improvements and methods employed, and indicate (by name and date of publication) where further particulars can easily be obtained. Reading them over is an easy way of reviewing any subject, and is of special value when the engineer has taken pains to record his observations of work, the tables he has constructed, the costs of construction on which he has been connected, and other data which will help him in future designing and estimating, and which, without the incentive, he often fails to collect, or, having collected, fails to arrange, index or get into convenient shape for reference. Elihu Cunyngham Church.

4 East 130th St., New York City, Jan. 3, 1905.

## A British Treatise on Reinforced Concrete.

Reviewed by Prof. A. N. Talbot,* M. Am. Soc. C. E.

REINFORCED CONCRETE.—By Charles F Marsh, Assoc. M. Inst. C. E., Assoc. M. Inst. M. E. New York: D. Van Nostrand Co. Cloth; 8 × 11 ins.; pp. 345; tables and 512 illustrations, mostly in the text. $7, net.

This elaborate attempt to cover the field of reinforced concrete is successful in giving much information about this form of construction. The author states that the building laws and regulations existing in England must be amended before reinforced concrete construction may be used with economy, which may be accepted as an explanation of the fact that most of the material of the book has been drawn from foreign sources, including much from the United States. In fact, comparatively little of the book other than the author's deductions is of British origin. The point of view is that of an outside observer.

Part I. gives a general review of the subject and discusses the advantages and disadvantages of reinforced concrete. Part II. devotes 90 pages to the description and illustration of fifty "systems" of reinforcement. In some respects this partakes of the nature of a museum catalogue, but many of these systems suggest ideas or the avoidance of defects, and of course the principal methods now in use are included in the list. Part III. gives only 30 pages to materials and their requirements and to their combination and economical considerations, and is only fairly good. Part IV., on Practical Construction, includes in its 60 pages descriptions and illustrations of the processes involved in construction, the views given of work in progress being a feature of it. Facing for reinforced work, moulds, false work and forms of reinforcing bars are among the topics treated. The fifty pages of Part V., on Experimental Research and Data Deduced Therefrom, give results of investigations of Bach, Considère, Christophe, Hatt, Lanza, and others. The author decides to neglect the tension strength of concrete, adopts ten for the ratio of the coefficient of elasticity of steel to that of concrete for the highest value of compression to be used, allows for general purposes 500 lbs. per sq. in. compression in the concrete and 15,000 lbs. per sq. in. tension in steel. A large portion of the book, 150 pages, is devoted to Part VI., Calculations, which includes a number of diagrams and tables. The author says that although much has been accomplished recently to extend our knowledge of reinforced concrete we are unfortunately still uncertain as to the true significance of the added knowledge. He finally adopts the parabolic form of stress-deformation curve for concrete in compression, and decides that the maximum elongation of the concrete in tension must not exceed 1-1,000. In his beam formulas the full parabola is used in getting the compression stresses, although the maximum stress in compression may not warrant it, and this and the high value assumed for the coefficient of elasticity of concrete puts the neutral axis above its probable position, and the formulas do not give the real value of the resisting moment nor of the compression stresses. The diagrams and tables for position of neutral axis and value of resisting moment must then be used with caution and after a study of the conditions assumed for them. Tie-beams, slabs, hooped reinforcement and shear are given a share of the space. The formulas and methods of calculation of Hennebique, Ritter, Considère, Christophe and others follow. Some attention is given to arches and to pieces subject to combined stresses.

The ninety-five pages given to Part VII., Structures, is made up largely of views of structures completed and uncompleted, many of which have been illustrated in Engineering News. The book closes with an index of 15 pages, which seems to be good.

The book is a sumptuous volume, printed in large type, with wide margins and large illustrations. It is full of information, though in writing on a subject not yet fully investigated it must not be expected that every statement will be borne out by further investigation or that writers may not have changed their minds on quotations attributed to them. The book must be regarded as a record of methods and opinions rather than as a final authority on the subject. It will not appeal to the student unless he has already made some study of the subject. Engineers engaged in concrete work will find much of interest to them, though they may not agree with the methods recommended. The ordinary purchaser of books will wish that its make-up had been modified so as to bring the same amount of material into a volume which could sell at a lower price.

*University of Illinois, Urbana, Ill.

## An O'd Letter on the Magnet.

THE LETTER OF PETRUS PEREGRINUS ON THE MAGNET, A. D. 1269.—Translated by Brother Arnold, M. Sc., Principal of La Salle Institute, Troy. With Introductory Notice by Brother Potamian, D. Sc., Professor of Physics in Manhattan College, New York. New York: McGraw Publishing Co. Paper; 6½ × 9 ins.; pp. xix. + 41; 4 figures in the text. $1.50.

The orienting property of the magnet was studied in Europe by several "raw scientists" of the twelfth and thirteenth centuries. Peter of Maricourt, a French soldier, called Peregrinus, was in this number, and he has the special distinction of having not merely theorized and written, but also done some careful experimenting upon magnets. While with the French army besieging the Italian town of Lucera, in 1269, he wrote an account of his observations on loadstones and magnetized needles in a letter to his friend Siger of Foucaucourt. This letter, of which several copies exist, is presented in English translation in the book above noted. The translation was made from the first printed edition (Latin) of the letter, published by A. Gasser in Augsburg, 1558. An English translation was made by Prof. S. P. Thompson and published in a limited edition, 1902. The present book makes the interesting letter of Peter the Pilgrim available to wider circles.

Briefly, Peter's observations were: that a loadstone has definite polarity, one end pointing always north, the other south; that the north pole of one stone attracts the south pole of another but repels the north pole; that a loadstone divided by an equatorial cut forms two complete loadstones, each having all the properties of the original; that a needle can be magnetized by bringing it into contact with a loadstone, and will then be a north-finding instrument; that a magnet best preserves its strength where oriented in the meridian; that a spherically turned loadstone, accurately balanced on a polar axis, will, if this axis is set parallel to the "axis of the heavens," rotate with the heavens. The latter observation is thus summarized: After describing a loadstone mounted in careful balance on an axis, he says:

> Then place the stone with its axis in the meridian, the poles resting on the pivots. Let it be moved after the manner of bracelets so that the elevation and depression of the poles will equal the elevation and depression of the poles of the heavens of the place in which you are experimenting. If now the stone be moved according to the motion of the heavens, you will be delighted in having discovered such a wonderful secret; but if not, ascribe the failure to your own lack of skill rather than to a defect in nature. . . . With such an instrument you will need no timepiece, for by it you can know the ascendant at any hour you please, as well as all other dispositions of the heavens which are sought for by astrologers.

Peter also describes an instrument like our surveyor's compass, for astronomical observations; and at the last a perpetual motion machine containing a magnet.

The publishers deserve commendation for presenting this interesting old letter in an attractive form.

HANDBOOK ON SANITATION.—A Manual of Theoretical and Practical Sanitation. For Students and Physicians; for Health, Sanitary, Tenement-house, Plumbing, Factory, Food and Other Inspectors, as Well as for Candidates for All Municipal Sanitary Positions. By George M. Price, M. D. Second Edition, Revised and Partly Rewritten. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5 × 7½ ins.; pp. 301; 28 illustrations in the text. $1.50 net.

A considerable part of this book has been rewritten and rearranged and much of the State and city legislation governing tenement houses, plumbing and the like in New York City has been omitted. The result is a very slight reduction in the size, a more up-to-date treatment and a general improvement of much of the subject matter. The first edition appeared late in 1901 and was reviewed in Engineering News of April 17, 1902.

The book presents in brief compass and generally clear language a wide range of information on sanitary and related topics; but unfortunately so many topics are presented that the information on some of them is too meager to be of much service, while the leading principles of sanitary science are not set forth in order of relative importance.

On p. 52 there is a misleading paragraph on cremation as a method of sewage disposal and on pp. 55-6 the author repeats a series of errors made in Chapin's "Municipal Sanitation in the United States," where it is stated that "a portion of the *sewage*" (italics ours) of Atlanta and eight other cities, all named, "is cremated." The facts are that a number of years ago a portion of the night soil of these places was burned in garbage furnaces. It is not true, as stated on p. 58, that most cities use the combined system of sewerage, and it is misleading to single out Memphis, Tenn., and Keene, N. H., as places where the separate system has been used "for a number of years with complete satisfaction," as though their adoption of and experience with the separate system was in any way exceptional.

SEATS OF THE COLONISTS AND OTHER FURNISHINGS.—Part I. Edited by William Rotch Ware. Illustrated, Largely with Measured Drawings by Horace C. Dunham. New York: The American Architect Co. Portfolio (loose leaves); 9 × 14½ ins.; pp. 24; 28 full-page plates. $5.

The great revival of interest in colonial furniture has led to the publication of several popular books. There has been a demand, however, for books of a more technical sort, which should treat the subject in a more authoritative fashion and with more detailed description of the elements of design involved in these colonial relics which are nowadays sold at such enormous prices.

To meet this demand the work above announced is being compiled under the direction of the American Architect Co. It will be issued in four parts. Part I. is devoted wholly to the chairs used in colonial days. It opens with a useful glossary, compiled by Mr. Wm. B. Bigelow, of terms which relate to colonial furniture generally. Then comes a general article on the work of the three most famous designers, Chippendale, Hepplewhite and Sheraton. Next is a special account of Chippendale's work by R. Davis Beun which completes the text.

The plates are partly half tone reproductions from photographs, but most of them are scale drawings, suitable for use by the draftsmen or furniture designer desiring to reproduce any of the pieces shown. These plates, it should be said, are devoted almost without exception to examples of Chippendale chairs. There are no drawings to show the work of the other early designers and the well-known Windsor chairs are given only a brief mention in the glossary and a single perspective sketch of small scale. The chief value of the work, therefore, is to be found in the scale drawing of Chippendale types above referred to; and it is these which will doubtless serve to attract subscribers to the monograph.

ORDINARY FOUNDATIONS.—Including the Cofferdam Process for Piers. With Numerous Practical Examples from Actual Work. By Charles Evan Fowler, M. Am. Soc. C. E. Second Edition, Revised and Enlarged. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 6 × 9 ins.; pp. xxvi + 314; 149 figures and 15 tables in the text. $3.50.

In the present volume the author has enlarged and extended the scope of his book on "The Cofferdam Process for Piers" so as to include the discussion and description of other classes of ordinary foundation work, such as cylinder piers, open caissons, small pneumatic caissons, timber piers, and pile bents. As it is now the book is a general treatise on foundations of all kinds, excluding those of unusual size and difficulty and requiring methods and machinery of exceptional character and cost. Briefly summarized, we have one chapter of historical matter, seven chapters on cofferdam construction, one chapter on cylinder and caisson foundations, one chapter on pumping and dredging machinery, two chapters on foundations, two on the location and design of

piers, one on cement and concrete and one on timber piers and timber preservation. In conclusion there are half a dozen appendices and 15 tables. The book has been substantially improved by the additional chapters, but it is, however, chiefly valuable for its very thorough discussion of the cofferdam process of foundation construction.

## Smoke Prevention.

Reviewed by Robert S. Hale,* M. Am. Soc. M. E.

SMOKE PREVENTION AND FUEL ECONOMY.—Based on the German Work of E. Schmatolla. By Wm. H. Booth, M. Am. Soc. C. E. (formerly of the Manchester Steam Users' Association), and John B. C. Kershaw, F. I. C. New York: The Norman W. Henley Publishing Co. Cloth; 5½ × 8½ ins.; pp. 194; 75 figures in the text. $2.50.

For those interested in the elements of smoke prevention and combustion this would be an excellent hand-book if it were not marred by faults of arrangement and omission that will doubtless be corrected in future editions. Even as it stands the ideas are well and clearly expressed, and though dislike of a well-known American type of boiler leads the authors to make use of expressions that seem exaggerated yet with this exception there are few actual errors.

The subject is treated in three divisions, which do not follow in consecutive order. The first of these is a brief and elementary statement of the chemistry of combustion (Chapter I.). This concerns itself chiefly with the combustion of carbon and hydrogen and would have been very much better if more stress had been laid on the fact that the reactions are very much more complicated than those given. For instance, pure carbon will not combine with oxygen unless at least a trace of hydrogen be present. Apparently the hydrogen acts in some way as a carrier, and the fact is important in explaining the greater ease of ignition of soft coal in spite of the cooling effect of gasification. Without such explanation it would seem as though hard coal, where less cooling from gasification occurs, should ignite most quickly. The fact that CO is never formed directly but that carbon burns first to $CO_2$ and that the CO is formed only when the $CO_2$ is brought in contact with red hot carbon should have been referred to here instead of in a later chapter.

The second division, for which we must skip to Chapter IV., treats of the tests and analyses of the products of combustion. The only draft gage referred to is the ordinary U-tube and one can hardly agree with the recommendation to turn the mouth in the direction from which the gases are coming in order to obtain a greater reading. This would make it into a Pitot tube so that the reading would be a combination effect depending partly on the draft pressure and partly on the velocity of the gases. The section on examining the color of the furnace gases through glass of varying color is most interesting and so far as the reviewer knows it is new.

In discussing the measurement of the temperature of the waste gases the iron ball pyrometer is recommended as superior to the mercury thermometer with an inert gas above the mercury. It is true the latter device is fragile, like any glass instrument, but it is convenient and quite accurate. On the other hand, the iron ball pyrometer requires a much more accurate though lower reading thermometer, an accurate knowledge of the specific heat of the ball of iron used, which may vary 20%, according to whether it is cast, wrought or malleable, and most delicate manipulation to give anything like accurate results. The reviewer would have classed the iron ball pyrometer with the barrel calorimeter for determining the moisture in steam and would have recommended putting rods of lead, tin, copper and zinc in the flue and noting which melted as the best rough method of determining the temperature of the flue when no thermometer was available.

The section on gas analysis is fairly good, though the description of the Honigman pipettes for determining the $CO_2$ might have been omitted. Any experimenter would naturally provide himself with the Orsat apparatus for determining both $CO_2$, CO and $O_2$, and after learning the manipulation of the Orsat the fact that in a few cases there would or might be a slight saving in time by the use of the Honigman would not warrant learning another set of manipulations. Several forms of Orsat much superior to the one in the text have been described in the transactions of the engineering societies of late years, but they may not yet be on the market.

It would have been interesting if the authors had given the calculations by which the heat losses can be figured from the gas analyses and temperatures. Of course the student can find them in other works but this would have seemed an especially appropriate place for them.

The third division of the subject is an historical review of smoke prevention from the time of Watt and is scattered about as follows: The Introduction and Chapter II. treat of present methods of burning fuels; Chapter III. deals with improved methods of burning fuels; and Appendix I. is devoted to English, German and American patents. This is the least satisfactory part of the book. As evidences that this section needs a thorough revision it may be noted that Watt's advice on burning soft coal is referred to without any mention of his patent of 1785 for a smokeless furnace nor of the close resemblance of that furnace to the one shown by Fig. 20 of this book; that the use of a furnace on wheels and of clockwork devices for regulating air admission above the fire are treated under "present methods of burning fuel" (the furnace is to be wheeled in front of the boiler to be fired next!); that one of the patents given at length claims a 20% saving by spraying a weak solution of saltpetre above the fire (we may well be glad that this is described under English Patents); and that the E. S. E. stoker, an English stoker of the sprinkling type, is described under the head of American patents, as is an English underfeed stoker, while none of the American underfeed stokers are referred to at all, either among the American or English patents.

In spite of its errors of omission and commission the book is of interest and value to students of the subject. Its chief fault is one we have not referred to because it is the fault of nearly all writers on smoke prevention. It is of no very great importance to find out how to build a furnace that can be fired smokelessly. Watt did that over a century ago and many others have done it since in many different ways. The real problem is to design a furnace that the ordinary $12 a week fireman will not permit to smoke in practice. This is a far more difficult problem and one that has yet to be solved.

*925 Boylston St., Boston.

THE TELEPHONE SERVICE: ITS PAST, ITS PRESENT AND ITS FUTURE.—By Herbert Laws Webb, M. I. E. E. London: Whittaker & Co. New York: The Macmillan Co. Paper; 5½ × 8½ ins.; pp. 118; illustrated. 1s. net; American price, 40 cts.

This book is a popular writing for the education of the public in matters of the telephone system considered as a machine. Nearly every one knows roughly how the telephone *instrument* operates, but few are acquainted with the working of the system back of the subscriber's station. The author therefore passes the instrument with a brief reference to its development, but sketches in some detail the exchange switchboard and the method of interconnecting several exchanges. The various manipulations in answering calls, making connections and clearing a line are described at length. From this matter, the author then deduces some principles of proper telephone manners, and illustrates them by several anecdotes. Passing to the subject of charging for telephone service, he makes the merits of the message-rate system apparent; he then tells why telephone service is worth more to the subscriber as the number of subscribers increases, and hints that the cost of the service grows similarly. Finally, he portrays the conditions surrounding telephony in Great Britain as a result of the legal decision that telephones come under the Telegraph Act which gives the government a monopoly of electric communication. The tone of this chapter is bitter against the British "governmental obstruction and repression," and more strongly so against the prospect of the government taking over the telephone business within a few years. The closing paragraph expresses this definitely:

It is sad to contemplate the manner in which the electrical industries in this country have been strangled by over-legislation and State interference. Submarine cable work is the only branch of electrical engineering which has escaped, and that is presumably because submarine cables are laid under the sea and not on British soil. Electric lighting and electric traction were repressed by legislation until other countries had far out-distanced this in electrical manufactures. The State monopoly of telegraphy has stamped out inventive and manufacturing enterprise in telegraph work in Britain, and now the telephone is to follow the telegraph in constituting a closed electrical monopoly under Civil Service control, at the doors of which future inventors will knock in vain.

FOWLER'S ELECTRICAL ENGINEER'S YEAR BOOK AND DIRECTORY OF LIGHT, POWER AND TRACTION STATIONS.—Manchester, England: Scientific Publishing Co. Boards; 4 × 6¼ ins.; pp. 49 + [illegible] tables, and 90 figures in the text. 1½ shillings, or 40 cts., net.

The year-book feature of this little manual is really only a minor part, comprising some hundred and fifty pages at the end, where are catalogued the electric lighting and power stations in the United Kingdom, with some descriptive particulars noted for each one. The bulk of the manual forms an electrical engineer's pocket-book, containing matter ranging from a table of fuse wires to a description of methods of measuring polyphase power, or from instructions for starting a shunt dynamo to a description of the Nernst lamp. The matter seems to be good and up-to-date, and its arrangement as satisfactory as that of any hand-book.

LEBENDIGE KRAEFTE.—Sieben Vorträge aus dem Gebiete der Technik. By Max Eyth. Berlin: Julius Springer. Paper; 6 × 8½ ins.; pp. 284; tables and figures in the text. 4 marks or $1.60.

Here are seven entertaining and instructive discourses which the reader of German may enjoy. Their various subjects are: Poetry and Engineering; Water in Modern and Ancient Egypt; The Development of Agricultural Machinery in Germany, England and America; Mathematical and Scientific Curiosities of the Cheops Pyramid; Inland Navigation and Agriculture; A Pharao in the Age of Steam; On the Philosophy of Invention. The author's style is generally excellent, and his writing has the merit of being founded on personal familiarity with the various subjects discussed.

CRUSHED STONE AND ITS USES.—Facts of Importance in connection with Modern Concrete Construction. Compiled by W. J. Jackman. Chicago: The Producers' Supply Co. Cloth; 6 × 9 ins.; pp. 110; numerous half-tone illustrations. For complimentary distribution.

This is a collection of 40 articles compiled from various sources and relating to concrete and works in concrete. In many cases the articles have apparently been written for the book and in other cases they have been taken from the engineering papers, engineers' reports and similar sources. The articles are for the most part rather geperal in character, and it goes without saying that they are all highly favorable to concrete as a structural material. Altogether the book is well worth having on file.

WATER-WORKS SYSTEMS FOR SMALL TOWNS, CITIES, ETC.—Published specially for city officials who are contemplating water-works construction. By Richard C. Huston, C. E. Laurel, Miss.: The author. Paper; 5 × 7 ins.; pp. 64.

A few simple statements regarding water-works are followed by a compilation of "useful information." The latter will be of little or any value to the class of people likely to profit from the main text. Mr. Huston is Vice-President of the recently organized American Public Works Association and includes the "rules" of that body in his pamphlet.

INTERNATIONAL ACETYLENE ASSOCIATION.—Report of the Seventh Annual Meeting held at St. Louis, September, 1904. Chicago: Nelson L. Litten, Secretary, 324 Dearborn St. Paper; 5 × 7½ ins.; pp. 97.

The acetylene industry in France is reviewed by Pierre Rosenberg and in Germany by D. J. H. Vogel. Other papers deal with town lighting, mining lamps, carbide manufacture, insurance problems, cooking and heating and acetylene generators.

AMERICAN STREET RAILWAY ASSOCIATION.—Report of the Convention held at St. Louis, Mo., October, 1904. Chicago: T. C. Penington, Secretary, 2020 State St. Paper; 6 × 9 ins.; pp. 297; illustrated.

The principal matters of technical interest are the reports and discussions on steam turbines; steam turbine power plant; the Diesel oil engine; transfers. Also the report of the committee on Rules for Conductors and Motormen.

## Fuel Gas.

Reviewed by Alfred E. Forstall.*

PRODUCER GAS.—A Sketch of the Properties, Manufacture and Uses of Gaseous Fuel. By A. Humboldt Sexton, F. I. C., F. C. S. Manchester, Eng.: The Scientific Publishing Co. Cloth; 5½ × 8½ ins.; pp. 214; 82 figures in the text. 10s. or $4 net.

This book might have been given the title Fuel Gas, since it is not confined to producer gas alone but covers in a general way all the different gases used for fuel purposes.

The opening chapter begins with a statement of the chemical and physical characteristics of each of the different gases found mixed with each other in varying proportions in all fuel gases. Then follows an explanation of the correction of volume of gases under changes of temperature and pressure and of the calculation from the percentage composition by volume of a mixture of gases, of the percentage composition by weight and also the amount of air required for, and the volume of products resulting from, its combustion. The next chapter deals with the calculation of the calorific power and calorific intensity of fuels and the amount of heat carried away by the products of combustion.

The characteristics of natural gas, coal gas, oil gas and acetylene are briefly given in the third chapter. The fourth chapter takes up the chemistry and physics of the formation of producer gas proper, that is the mixture of gases produced by the incomplete combustion of carbon by means either of air alone or, as is now the exclusive practice, of a mixture of air and steam.

The fifth and sixth chapters deal with descriptions of steam jet blowers and of producers themselves. Following these a separate chapter is devoted to the Mond producer, which is taken as typical of the class of producers which use a great excess of steam and produce a gas containing a greater volume of hydrogen than of carbon monoxide, the extra cost of this method of operating being compensated for by the recovery of the ammonia produced.

Another chapter deals with the manufacture of blue water gas and gives descriptions of three forms of apparatus for the purpose, these including the Loomis-Pettibone and the Dellwik-Fleischer.

Chapter IX. contains a discussion of the conditions that must be fulfilled by the producer and of the methods employed for doing away with or removing the tar formed when bituminous coal is used as the fuel. The final chapter takes up the uses of the gaseous fuel for various purposes, such as boiler firing, heating of furnaces and generation of power by means of gas engines.

The physical and chemical chapters are in general well written. The use in all calculations of the specific heats at ordinary temperatures of the products of combustion without calling attention to the fact that they increase with increase in temperature is, however, misleading, since this increase materially affects both the calorific intensity of a fuel and the amount of heat carried away by the products of its combustion. If the author had used in his examples the average specific heats of the products of combustion at the temperatures with which he is dealing the answers to these examples would have been quite different from the figures given. The statements made in the descriptions of marsh gas, or methane and ethylene, that the former is rarely present in large quantities in coal gas while the latter is present in considerable quantities are wrong and difficult to understand in the light of the analysis of coal gas given later, which shows it to contain 36% of methane by volume and 51.4% by weight, while ethylene is present only to the extent of 3.8% by volume and 9.5% by weight.

In giving the descriptions of producers the modern types of producers working with forced draft are arranged in five groups according to the manner in which the fuel is supported and the ashes and clinker are removed. These groups are bar bottom producers in which the fuel is supported by a grate; solid bottom producers in which the fuel rests directly on the bottom of the producer; water bottom producers which are arranged so that there is an opening around the bottom of the producer sealed with water, through which ashes and clinker can be removed without interfering with the action of the fire; automatic producers, which are provided with arrangements for removing the ash and clinker automatically, and blast furnace producers which are operated in the same manner as a blast furnace. One or more producers typical of each group are selected and described both as to construction and operation by text and illustrations. The descriptions are clear, though not detailed. In connection with many of them analyses of the gas produced by the machines treated of are given.

In addition to the descriptions contained in the body of the book, those of 32 producers of different kinds, none of which date farther back than 1897, are given in an appendix. This descriptive portion should be especially valuable to those who wish information as to what has been patented in apparatus of this kind, there being altogether some fifty producers described. The descriptions would have been of more value to an intending user if the author had given some opinion of his own as to the claims made for each machine instead of depending almost entirely upon the statements of the patentees. Practically the only opinion which he gives is that the arrangements proposed for producing from bituminous coal a gas free from tar by causing the gas distilled from the coal to pass through a greater or less depth of incandescent fuel cannot be depended upon to produce a gas entirely free from tar and that where such a gas is needed it is necessary to wash it after it leaves the producer.

The author also makes the statement that a coking coal cannot be used to advantage in gas producers. This is correct, since the different mechanical arrangements adopted for breaking up the mass into which a coking coal agglomerates under the influence of heat are not capable of continuous successful operation.

The chapter on water gas contains aggravated instance of the tendency, in the absence of any special knowledge on the subject, to accept as facts statements boldly put forth by interested persons as to the advantages of one process and the inherent disadvantages of all previous ones. The author, evidently relying upon the assertions of the promoters of the Dellwik apparatus, which he quotes quite extensively, states that in all forms of water gas plant in use before the introduction of the form named the conditions were such that it was impossible during the heating up stage to oxidize the carbon more completely than to carbon monoxide, while in the Dellwik apparatus the combustion is to carbon dioxide. Whatever may have been true abroad, water gas makers in the United States knew, long before the appearance of the Dellwik process, how to blast (when the handling of the generator was not influenced by the necessity for using the blast gases to furnish heat to gasify oil for carburetting the gas) in such a way that these blast gases would contain more carbon dioxide than carbon monoxide, which is all that is claimed in the Dellwik patent. In the practical use of the Dellwik apparatus there is no doubt, as is stated by the author, that the amount of carbon dioxide in the blast gases is, in many cases, less than 15%, which is no better than was done for years in water gas generators in the United States when these were used for the sole purpose of producing blue water gas.

Several typographical errors were noticed in reading over the book, the most important being an omission of a figure by which the flame temperature of hydrogen burned in air is given as 269° C., when it should have been 2,690° C.

Taken altogether this book will be of value to any one interested in the subject of gaseous fuel, which the rapidly increasing use of internal combustion engines is making more and more important. It does not, however, entirely cover the field, and there is room for a treatment of the subject, not only from the American standpoint, but also from that of the man who is concerned with the actual working of the producers, and therefore wishes to know not only what points are to be aimed at in working them, but also how he is to proceed in actual practice to obtain the desired results.

*Consulting Engineer, late Secretary American Gas Light Association, 58 William St., New York City.

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THE GROUPING OF PUBLIC BUILDINGS.—Bulletin No. 2 of the Municipal Art Society of Hartford, Conn. Compiled by Frederick L. Ford, City Engineer, Hartford. Hartford, Conn.: The Society. Paper; 6 × 9 ins.; pp. 85; illustrated. (Send 6 cts. in stamps to G. A. Parker, Park Vice-Pres. American Civic Association, Hartford, Conn.)

We have here a collection of papers which should further the movement for effective civic centers through the grouping of public buildings. Mr. Ford discusses the possibilities of a notable group of public buildings at Hartford, with the State Capitol as a center. Mr. Parker writes of what has been done and what remains to be done in the same general way at Providence, and also of the proposed civic center at Cleveland. Mr. Milo R. Maltbie, Assistant Secretary of the New York Art Commission, describes some of the achievements that have made Berlin, Paris, Vienna and other European cities notable. Other papers, both general and specific, combine with those named to make a suggestive and stimulating pamphlet.


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## The Land Treatment of Sewage.

ROYAL COMMISSION ON SEWAGE DISPOSAL.—Supplementary Volumes Presented with the Fourth Report of the Commissioners Appointed in 1898 to Inquire and Report What Methods of Treating and Disposing of Sewage (including any Liquid from any Factory or Manufacturing Process) May Properly be Adopted. Reports to the Commission by Dr. McGowan, Dr. Houston and Mr. Kershaw on Land-Treatment of Sewage. London, England: Eyre & Spottiswood, East Harding St., Fleet St., E. C. Paper; 9 x 13 ins.; many tables and illustrations, including folding plates of maps and diagrams in colors. 30s. 2d. the set, or $12. (Prices for each part given below.)

Part I.: General Report. Pp. 116. 3s. 9d., or $1.35.

Part II.: Chemical Report. By Dr. G. McGowan. Pp. 328. 9s. 7d., or $3.85.

Part III.: Bacteriological Report. By Dr. A. C. Houston. Pp. 214. 5s. 3d., or $2.05.

Part IV.: Engineering and Practical Report. By G. B. Kershaw. Pp. 129. 11s., or $4.40.

Part V.: Methods of Chemical Analysis as Applied to Sewage and to Sewage Effluents. By Dr. G. McGowan, R. B. Floris, A. I. C., and R. S. Finlow, B. Sc. Pp. 70. 7d., or 25 cts.

After visiting 29 sewage farms the experts employed by the Royal Commission on Sewage Disposal chose eight of those farms for special observation. The farms were selected largely to represent different kinds of soil, as follows: Aldershot Camp, sand; Croydon (Beddington), gravelly loam; Nottingham and Cambridge, light loam; Rugby (high level), heavy loam; South Norwood and Leicester, clay; Altrincham, peaty soil and sand. The farms were also chosen with a view of studying the treatment of sewage either wholly or principally domestic in character. Separate, partly separate and combined sewerage systems were involved and where storm water was admitted to the sewers varying proportions of it were treated at the different works studied. There were, as might be expected, wide ranges in the volumes of sewage per capita and per acre of land treated. In all but one of the eight works the sewage was screened or partially screened and at six of them settling tanks were used. The land treatment practiced is classified roughly as surface irrigation and land filtration, the latter resembling our intermittent filtration, but being less elaborate in construction.

As may be seen from the above headings, the five parts of Vol. IV. of the report here presented are classed as General, Chemical, Bacteriological, Engineering and Practical and Chemical Methods, respectively. The general report summarizes and presents in various combinations the most important features and conclusions of the other reports and is sufficient for all but specialists in sewage treatment, although the general student would find much of value in the general report, including plans of all the farms and details of portions of some of the works. Each report forms a complete whole, except for references to the others for some details. This will be a great convenience to those who content themselves with less than the five Parts, or who read the several Parts at well-separated intervals. For those who pass rapidly from one Part to another so much repetition is likely to become tedious. In the General section, also, there are many repetitions, each farm being taken up, as in the several Parts, in order and from various points of views.

Probably most persons who attempt to read all five Parts would have gotten a clearer view of the results of the study as a whole had all the information for each works been presented together, instead of in such a fragmentary manner. But it must be admitted that the plan of presentation adopted has decided advantages, including as it does both the analytical and synthetical methods.

The Chemical report contains studies of the soils and subsoils of the several farms, detailed analyses of sewages and effluents and studies of the relations of the various chemical constituents to each other.

In a brief introduction to the biological report Dr. Houston remarks, in effect, that in Great Britain, at least, the bacterial character of sewage farm effluents was practically unknown prior to these investigations. Much more is known regarding the biological qualities of effluents from so-called bacterial processes. The latter effluents, it now appears, "are hardly safer in their possible relations to disease than [is] crude sewage." The studies of sewage farms here reported led Dr. Houston to believe that the effluents from such farms are also unsafe to discharge into drinking water.

The bacterial investigations of sewage farms made for the Commission included total counts on gelatin at 20° C. and on agar at 37° C.; examinations for B. Coli and B. enteritidis sporogenes and occasional streptococcus tests. At the request of the Commission much work was done on indol, "gas," neutral red broth and litmus milk tests. An appendix is devoted to studies, by Dr. Gordon, of the biological characteristics of 229 "Coli-like microbes" isolated from sewages and effluents and studied in pure cultures.

In Part V., on Chemical Methods, there is described not only the usual routine work of sampling and analysis but also the making of estimates of cellulose, the analysis of soils and sludges and the determination of heavy metals in sludges and in effluents.

Much caution is shown throughout the several reports lest grounds should be given for unwarranted conclusions regarding the efficiency of the various filtration and irrigation areas. In general, however, it is shown that land treatment may be relied upon, even with intractable soils, to give effluents that can be discharged into non-potable waters without risk of creating a nuisance. As to potable waters, as already stated, no such hope, even, is held out.

In comparing so-called bacterial with land treatment Dr. Houston remarks that the various artificial (rapid) processes are still in an experimental stage and that they are employed chiefly to produce non-putrescible effluents. Worked thus the bacterial results given by bacteria beds are not equal to those by land processes, but there seems to be no good reason why the effluent from bacterial beds might not be brought up to any "reasonable standard required" by slower rates of operation, or by passing the effluent through some special filter or by chemical treatment.

Reports on the so-called bacterial processes, apparently those in every-day work, are promised for the future. The Commission has now been in existence since 1898, and although complaints of its slowness and inconclusiveness are not uncommon in England, we in America, at least, are grateful to the Commission for making available so much valuable information on sewage treatment. Judging from the reports under review the final conclusions of the Commission will be very conservatively expressed, but there is reason to believe that the investigation as a whole will be a great aid in solving sewage disposal problems in all parts of the world. Howls of disappointment and much bitter criticism will undoubtedly arise in England when the final report is published, for obviously it cannot be expected that the report will please all, if, indeed, it does any large proportion, of the many individuals and both private and municipal corporations who are interested in the divers systems and sub-systems of sewage treatment now practiced or being promoted in Great Britain.

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STATE BOARD OF HEALTH OF MASSACHUSETTS.—Thirty-fifth Annual Report (1902-03). Boston: Pub. doc. Cloth; 6 x 9 ins.; pp. xxxvi. + 646; many tables.

Besides accounts of the experiments on water and sewage purification at Lawrence, which have given these annual reports a world-wide reputation, the present volume will be in demand on account of its 152 pages on the principal sewage purification works of Massachusetts. This special matter was prepared in compliance with a legislative act of 1901, requiring a yearly examination of the outlets of all main sewers and drains in the state and a study of the effects of sewage disposal. The annual report of the board for 1902 contained a report on outlets into the sea and into inland waters, taking up the various bodies of water receiving sewage and discussing the effect produced by the sewage. Sixteen sewage purification plants are described and details of their operation are given in this report.

The most notable lines of new work described as having been carried out at the Lawrence Experiment Station during the year were studies of the mechanical filtration of water and of the relation between troublesome odors from sewage works and very hard waters entering into the composition of the sewage. Mr. X. H. Goodnough, M. Am. Soc. C. E., continued as chief engineer and Mr. H. W. Clark as chemist to the board during the year.

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TRANSACTIONS OF THE AMERICAN CERAMIC SOCIETY.—Containing the Papers and Discussions of the Sixth Annual Meeting, held at Cincinnati, O., Feb. 1 to 3, 1904. Columbus, O.: The Society. Paper; 6 x 9 ins.; pp. 286.

Naturally the papers in these transactions are of especial interest to manufacturers of clay products. A paper on "The Colloid Theory of Plastic-


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# REINFORCED CONCRETE

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INTRODUCTION

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All the subject matter has been so arranged as to facilitate reference as much as possible, and the several systems used up to the present have been placed in alphabetical order, so that any particular one may be readily found when desired.

It is believed that the part relating to the calculations, covers all forms of construction in as concise and clear a manner as possible. The formulæ for slabs and beams, although giving somewhat smaller dimensions than those recommended by M. Christophe in *Le Beton Armé* (a standard French work on the subject), are still well on the side of safety, and it is hoped that the tables and diagrams may be of use in saving the labour necessary in making the requisite calculations. The subject of arches has been dealt with in as condensed a form as possible, compatible with a clear demonstration of the methods adopted for locating the pressure curve. The graphical method for finding the stresses to be resisted in domed coverings, is believed to be entirely new and greatly simplifies the treatment of these structures.

It has been considered advisable to illustrate the book very fully, in order that all the subject matter, where possible, may be rendered clearer, and that a true idea may be formed of the remarkable adaptability of reinforced concrete for constructural purposes.

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ity," by Allerton S. Cushman, and a paper on "The Tensile Strength of Raw Clays," by Heinrich Ries, contain matter that may be of interest to macadam road builders.

## Revised Editions of Two Standard Electrical Books.

THE ELECTRICAL TRANSMISSION OF ENERGY.—A Manual for the Design of Electrical Circuits. By Arthur Vaughan Abbott, M. Am. Inst. E. E., M. Am. Inst. M. E., M. Am. Soc. C. E., M. Am. Soc. M. E., etc. New York: D. Van Nostrand Co. London: Crosby Lockwood & Son. Cloth; 6 × 9 ins.; pp. xxx. + 675; 113 tables, 16 plates, 307 figures in the text and folding diagram in pocket. $5, net.

ELECTRIC LIGHTING.—A Practical Exposition of the Art for the Use of Engineers, Students and Others Interested in the Installation or Operation of Electrical Plants. Vol. I. The Generating Plant. By Francis B. Crocker, E. M., Ph. D., Professor of Electrical Engineering in Columbia University, New York, Past-President of the American Institute of Electrical Engineers. Sixth Edition. Entirely Revised. New York: D. Van Nostrand Co. London: E. & F. N. Spon. Cloth; 6 × 9 ins.; pp. 482; 213 figures in the text. $3.

Books that have been before the public so long as these call for passing notice rather than for review or criticism. It happens that the common subject of both works, industrial electricity, has been considerably developed in its applications during the past ten years; but the development has been more in extent than in method, and has had relatively little influence on the matter contained in these two books.

Mr. Abbott's "Electrical Transmission of Energy" is, in its fourth edition, still as useful, or rather necessary, as it was at its writing, ten years ago. The voluminous collection of information about wire, line construction, material and methods, distribution systems, and every other factor or phase of the electrical engineer's line-work, is modern today, especially so since the book was thoroughly revised for this edition. The representation accorded to long-distance transmission is not as full as one might wish, but there is good justification for brevity here because this field of work in each individual case offers a new and broad engineering problem—quite different from city distribution, or even electric railway supply, which are almost standardized.

Professor Crocker's comprehensive work, which, according to the preface has been "practically rewritten," also seems to retain most of its original merit, transferred to modern times. Written when electric lighting had developed to a modern condition in types and details, though not in extent or concentration, it had little to suffer from lapse of time. Old-fashionedness appears most strongly in the main characteristic of the book, its comprehensiveness. This feature, not strictly essential to the subject even ten years ago, seems to have become less appropriate as time went on. The extended chapters on boilers, engines and condensers, on buildings and chimneys, etc., etc., have become less useful than ever before. Some pages on steam turbines, on gas-producers, and the like, give a more modern touch to these chapters, but do not make them appear sufficiently justified to take space from the fuller description of switch gear and other vital details of modern generating stations.

The fact that all electric plants carry some lighting, while most of them have their greatest output in lighting, gives to a work on Generating Stations for Electric Lighting the character of a work on Electric Generating Stations in general. In this aspect the present volume is not satisfactory, not up with the times. It gives three-fourths its space to matter which we do not look for in such a work, and omits very much that we would look to see treated in great detail. The problems of the large lighting station are vastly more complex than those of the bi-polar motor, and they lie to large part in that refinement and complication of apparatus and arrangement which is necessitated by the size and vital importance of the modern lighting plant. These more complex problems can be treated both by discussion and by illustrative description, and such treatment is eminently in place in a modern book on Electric Generating Stations. On the other hand, the study of boilers, for example, is old and long, and no one really looking for information about boilers will go to a book on Electric Stations to obtain it. But perhaps this very comprehensiveness and generality will long keep Professor Crocker's work in favor as a college text.

## Elementary Graphic Statics.

THE ELEMENTARY PRINCIPLES OF GRAPHIC STATICS.—Specially Prepared for Students of Science and Technical Schools, and Those Entering for the Examinations of the Board of Education in Building Construction, Machine Construction, Drawing, Applied Mechanics and for Other Similar Examinations. By Edward Hardy. London: B. T. Batsford. New York: D. Van Nostrand & Co. Cloth; 6 × 7½ ins.; pp. 165; 192 diagrams in the text. $1.50 net.

Graphic statics is usually taught in the university or the technical college. The subject—as much of it as is usually taught—is simple enough, and except for the principles of Mechanics which it involves it might be taught in the primary school. An attempt to present it in simplest possible manner, so as to bring it before readers who have only a primary-school education, is exhibited in Hardy's "The Elementary Principles of Graphic Statics." This book evidently addresses itself to students in trade schools and similar English institutions.

The chief features of the simplification are: (1) A preliminary chapter on Graphical Arithmetic; (2) A rather rough-and-ready introduction to the definitions and ideas of Statics, in place of the fuller and less elementary treatment usually given; (3) A cautious avoidance of references to methods or results of algebra, geometry, or higher sciences; and (4) A language which strives to be perfectly simple, but is frequently ineffective and even awkward.

The preliminary chapter, which explains how the four operations of Arithmetic may be performed graphically by drawing lines and measuring them, is not absolutely necessary even in an elementary work of the character of this one; but it offers a good mental preparation for the more complex treatment of force problems by Graphics, and is therefore a commendable feature. The introduction to the principles of Statics, given in the second chapter, is weak, largely because it is not allowed sufficient space. As this part of the course is fundamental, clearness of ideas formed here is of prime importance; bearing in mind that his audience is little used to considering systems of forces in the abstract, the author should have taken the space and the pains to expound the first principles with axiomatic clearness.

The range of the book is: Composition of forces, force-polygon, funicular polygon, diagram of bending moment, graphical treatment of beams, and graphical analysis of simple trusses. In beams, it is shown how to draw the moment curve and the shear curve, for uniform or concentrated loading. In trusses, the construction of the force-diagram for several styles of pitched-roof and parallel-chord trusses is explained. All chapters of the book are provided with a good selection of examples, answers to which are collected in an Appendix.

It has repeatedly come to our knowledge that there is a demand and a need for a book of this class, but we do not recall that such a book has yet appeared in America. Mr. Hardy's work, while it might be better in several respects, notably in the quality of its English, has therefore the merit of being in a sense a pioneer.


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MECHANICAL DRAWING.—Part II. Problems in Descriptive Geometry, Shades and Shadows, and Perspective. By F. E Giesecke, M. E., Professor of Drawing, Agricultural and Mechanical College of Texas (College Station, Tex.). Chicago and New York: Eugene Dietzgen Co. Cloth; 9⅝ × 7 ins.; pp. 64; 25 plates. $1.

Part I. was favorably noticed in this Supplement for Nov. 11, 1903. Part II. consists of problems in the subjects stated above, "designed to provide the drawing room practice which students need to understand these subjects fully." The problems, both text and drawings, are clearly presented and the whole book appears to be well adapted for its purpose.


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TABLE OF CONTENTS ON APPLICATION TO

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## A Roadmaster's Manual.

THE ROADMASTER'S ASSISTANT.—A Manual of Reference for those having to do with the Permanent Way of American Railroads.—[By George H. Paine.] New York: The Railroad Gazette. Cloth; 4½ × 7¼ ins.; pp. 295; 308 figures in the text. $1.50.

This is a second edition of the book published in 1898 as a successor to the original book of the same name, written by Mr. W. S. Huntington in 1871 and revised by Mr. Charles Latimer in 1877. Although a second edition, however, the author's name is not given on the title page, but is simply noted in the preface. Possibly the revision was made by another writer, but still the book is practically as written by Mr. Paine. The general style, subject matter and arrangement are the same, but changes have been made in certain paragraphs to bring the matter up to date.

The book does not deal with principles or theory, but with the materials employed and the practical work involved in the maintenance of railway track. There is also a chapter on signals, and another containing a series of rules and tables relating to track material and the laying out of curves and turnouts. From the small size of the book and the wide field which it attempts to cover, the treatment is necessarily superficial and general, with only the briefest information in regard to individual subjects. Thus, in the brief reference to wood preserving processes it is noted that zinc chloride, being soluble, may be leached out of the timber, but there is no mention of the different methods by which such action is prevented. Nor is the reader given any clue as to the extent to which treated ties are used. In referring to concrete ties, it is stated that the concrete "is quickly disintegrated under the pounding action of the rail"; this may be true of some forms, but is certainly not true of others, which are in use on important railways. The concrete tie illustrated is also incorrectly named. Again, in the description of various rail joints, it is noted that welded and cast joints have been "experimented with, principally on street railway track"; as a matter of fact, however, the cast weld joint is standard on many street railways and is so extensively used that it is far from being experimental.

The book is profusely illustrated, having over 300 cuts in the text. They are not very well selected, however, and many of them might well have been omitted to give room for more complete information on important subjects. The ten cuts of hand and inspection cars, for instance, occupy considerably more space than they are worth. The type is rather heavy and is unfortunately printed on semi-transparent paper, so that the printing shows through and gives the pages a dirty and blurred appearance. There seems to be little reason for narrowing the printed matter to allow room for marginal headings. In spite of its defects, however, the book has value as a condensed review of track construction and maintenance.

## Imaginary Letters on Railway Management.

LETTERS FROM AN OLD RAILWAY OFFICIAL TO HIS SON, A DIVISION SUPERINTENDENT.—By Charles DeLano Hine. With a Postscript by Frank H. Spearman. Chicago: The Railway Age. Cloth; 5 × 7½ ins.; pp. 179. $1.50.

In general style this book is strongly reminiscent of that other Chicago production, "Letters of a Self-Made Merchant to His Son." The slang of the yard, the roundhouse and the caboose here replaces that of store and warehouse. Nevertheless, the book contains much matter of real interest and value and its author gives evidence of a keen insight into men and methods and a clear understanding of modern transportation problems. Not all the ideas put forth will command universal assent, but they are all likely to set men thinking, and the perusal of the book by railway officials of high and low degree is calculated to do good.

Particularly excellent are the author's remarks on discipline. They have such general application that we take space for the following extracts:

> Whatever safety appliances we adopt we shall never be able to eliminate entirely the element of human judgment, we shall never get beyond trusting someboby. Therefore, we must train our men to alertness. We must build up a loyalty that pervades every rank. Those roads have the fewest wrecks due to defective equipment which cater to the welfare of their men. Such roads do not expect a man to live on air. When repair work is slack they put their men to building cars and engines, taking advantage of the low price of material. If we have to operate so closely that we cannot make such wise investments in influence, we are grading the way to disaster. We are preparing to pay out later in wrecking, personal injuries, maintenance and renewal of equipment, much more than the expense of anticipating future needs by keeping our men employed and contented. No amount of engine and car inspection can overcome inherent defects due to careless workmanship. Will the track walker who knows not when he will be laid off prevent as many disasters as he whom we find time to tell in advance what tenure to expect? . . . .
>
> We too seldom make our subordinates feel that we are the gainers by having them in our employ. We are too likely to make them feel they are lucky to have a job. This may do for the indifferent men, but it puts no premium on superior ability and loyalty. It renders a discharge, when made, less effective as an example. You cannot treat all your men alike in all things. In a few things, collisions, stealing, booze-fighting, for example, you have to do so. In most things you must avoid destroying individuality. You must build up personal pride in each. Even sister engines of the same type do not steam or pull exactly alike. Man, made in the image of Deity, has pride, brains and courage to make more complex his disposition. Corporations have no souls. Railroad men have souls and good red blood. Their intelligence is an inspiration; their steadfastness, a psalm.

WATER SUPPLY AND IRRIGATION PAPERS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. F. H. Newell, Chief Engineer Hydrographic Branch. Washington, D. C.: Pub. Doc. Paper; 6 × 9 ins.

No. 106: Water Resources of the Philadelphia District. By Florence Bascom. Pp. 75; four plates and three figures in the text.

No. 107: Water Powers of Alabama, with an Appendix on Stream Measurements in Mississippi. By Benjamin M. Hall. Pp. 233; nine plates and nine figures in the text.

An area of about 915 sq. miles, located in Pennsylvania, New Jersey and Delaware, is included in the Philadelphia District. The specific subjects treated in Paper 106 are topography, rainfall and run-off, the geology of the water-bearing horizons and the present and future utilization of water supply and power.

In Paper 107, Mr. Hall states that prior to 1896 no systematic investigation of the water supply and power of Alabama had been made. He takes up in detail the principal streams of the State and their tributaries, thus adding one more to the valuable series of similar papers published by the Survey.

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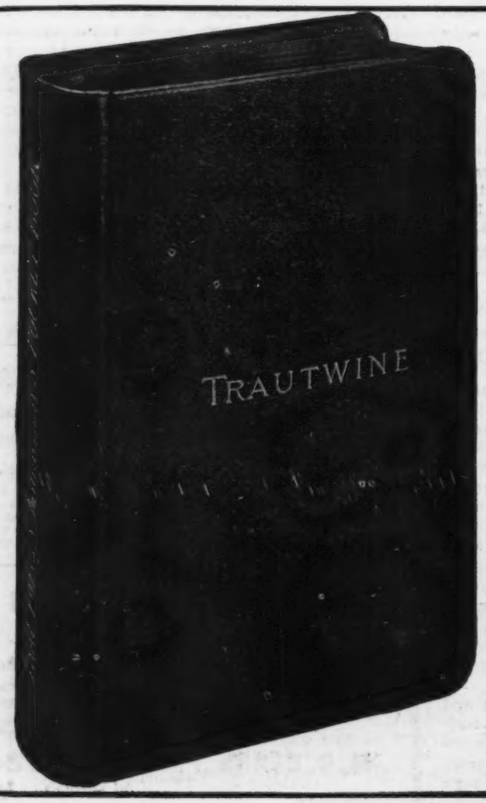
WINDMILLS IN FOREIGN COUNTRIES.—Special Consular Reports, Vol. XXXI. Washington, D. C.: Department of Commerce and Labor, Bureau of Statistics. Paper; 6 × 9 ins.; pp. 293; three figures in the text.

In response to a request from leading manufacturers of windmills, the various U. S. Consuls throughout the world were instructed to prepare reports on the actual and prospective use of windmills in their respective districts, and the climatic and other natural conditions affecting their use. The result is this volume of nearly three hundred pages.

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## Recent Development of Great Railway Systems.

THE STRATEGY OF GREAT RAILROADS.—By Frank H. Spearman. New York: Charles Scribner's Sons. Cloth; 6 × 8¼ ins.; pp. 287; 11 maps. $1.50 net.

The author of this book professes to make public the underlying motives which have governed the development of some of the great railway corporations of this country. One chapter is devoted to each of the following: The Vanderbilt lines, the Pennsylvania system, the Harriman lines, the Hill lines, the Gould lines, the Rock Island, the Atchison, the Chicago, Milwaukee & St. Paul and the Chicago & Northwestern. There is also a chapter each on "The Fight for Pittsburg," "The Rebuilding of an American Railroad" (referring to the Chicago & Alton), "The First Transcontinental Railroad" and "The Early Day in Railroading."

The "strategy" which the author sets forth is chiefly that which has been displayed during the past half dozen years or less. It is an interesting story which Mr. Spearman tells, and one is left wondering how much of it is true and where he got the information on which it is based. One instinctively doubts whether Mr. Hill or Mr. Harriman or Mr. Gould or the other financial magnates whose "strategy" Mr. Spearman claims to set forth have actually made him their confidante and whether what he gives is not really after all a popular interpretation of that strategy, which is doubtless generally right, but in some cases may be wrong.

We are in doubt as to how far the motives behind the deals and consolidations and reorganizations, of which Mr. Spearman writes, are those which he sets forth, and how far other motives, such as stock market operations and plans to make profits at stockholders' expense, have really been the governing impulse. For example, Mr. Spearman writes in glowing praise of great engineering feats, of vast expenditures on new construction, on railway rebuilding, on the acquirement of new properties.

We fear the stockholders of some of the companies which have carried out these great works are not by any means so certain of their strategic wisdom as Mr. Spearman seems to be. It is quite within the possibilities that the historian who follows Mr. Spearman a few years hence may write with as contemptuous a tone of some of our present day financiers as Mr. Spearman frequently assumes in this book in writing of the strategists of the '70's and the '80's.

With this advance word of caution we can commend the book as one which will interest every engineer who cares to study the larger economic problems of the transportation industry and will give him, indeed, much valuable information not often available.

Mr. Spearman tells us, for instance, that grain elevator property in Chicago has been rendered almost valueless by the changed financial condition of the Western farmer, who now holds his grain until he can get a satisfactory price, instead of selling it as soon as threshed as he used to do. Chicago has a storage capacity for 50,000,000 bushels of wheat, but at present her elevators contain only 4,000,000 bushels.

He shows how terminal facilities and division yards have come to determine the capacity and economy of a railway system regardless of its main line tracks. He describes the work done in improving the gradients and curvature on the Union Pacific, the Chicago & Alton and other railways and tells how the Pennsylvania Railroad has solved the problem of handling a traffic which has grown from 70,000 tons a year in 1852 to an equal amount in a single hour, half a century later.

In the tribute paid to Mr. Alex. J. Cassatt, the author says: "He has made unjust discrimination in railroad traffic a thing of the past." It would be very nice if this were the truth; but we are inclined to think that Mr. Cassatt himself would deny having brought about any such widespread reform.

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COST OF PUMPING FOR IRRIGATION.—Bulletin No. 49, Agricultural Experiment Station, University of Arizona. By Sherman M. Woodward. Tucson, Ariz.: The Experiment Station. Paper; 6 × 9 ins.; pp. 14.

Brief descriptions of nine pumping plants are followed by a table giving particulars for each plant regarding the fuel used and its cost, the kind of pumps and the work performed by them and the cost of fuel, attendance, oil, repairs, etc., and total cost per horse-power hour; also cost of lifting 1-acre-ft. to a height of 1 ft. and to the surface of the ground. A single plant is taken up in more detail and monthly figures of its operations are given. The various plants listed were visited by the author.

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A TREATISE ON METAMORPHISM.—By Charles Richard Van Hise. Vol. XLVII., Monographs of the U. S. Geological Survey. Washington, D. C.: Pub. Doc. Cloth; 9 × 12 ins.; pp. 1,286; 13 plates and 32 figures in the text.

To the geologist this huge monograph will doubtless prove of value, not only because it summarizes much that its author and other geologists have previously written in various papers, but also because it gives the latest views of a recognized authority on ore formation. The first few chapters are largely given up to enunciation of principles and laws of chemistry and physics. We note that, so far as the matter relating to physical chemistry is concerned, there is very little quoted from the recent work of chemists of this country or of Germany, which is the more to be regretted since we have no work in English that is up to date, while all the older works can be purchased and studied at first hand.

The impression left by an examination of the contents of this monograph is that it contains little that is new, and that the time and money used in writing and printing it might have been spent to better advantage in laboratory experiments. There are given, for example, many chemical equations of hypothetical reactions, which, so far as we know, have never been demonstrated to be correct by laboratory tests. Briefly put, could not the science of geology have been advanced far more by otherwise using the brains and the money here used in producing some 400,000 printed words?

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BOSTON FINANCES.—Receipts and Expenditures of Ordinary Revenue, 1899 to 1903. Special Publication No. 10. Boston: Statistics Department. Paper; 9 × 12 ins.; pp. 163; tables.

In addition to the detailed figures for city departments we find a summary of the receipts and expenditures of Boston for 1903-4, grouped according to the uniform system of the National Municipal League. Dr. E. M. Hartwell is both the Secretary of the Statistics Department and Chairman of the League Committee on uniform municipal accounts and statistics. It may be explained that by ordinary receipts is meant receipts from taxes, rents, licenses and other current sources, as contrasted with loans, trust funds and book-keeping items.

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PAPERS READ BEFORE THE ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.—Philadelphia: H. B. Warner, Assistant Secretary, 22 South 15th St. Paper; 6 × 9 ins.; pp. 41.

This pamphlet contains the six papers read before the Association at its second annual meeting, held in New York City on Dec. 13 and 14. As will be noted, the printed papers appear somewhat less than a month after their presentation, making a record of prompt publication which could be imitated with advantage by other technical organizations. The list of papers is notable in including two by Mr. Clifford Richardson; one discussing the value of chemical research to the Portland cement industry, and the other a record of the author's very interesting studies into the causes of setting or hydration of hydraulic cements. The last paper will be printed in an early issue of Engineering News.

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It is announced that the well-known monthly, "Beton und Eisen," which has been edited and published at Vienna, Austria, by Mr. F. von Emperger, will henceforth be published by the old-established house of Wilhelm Ernst & Sohn, of Berlin, Germany. This change, which gives an added assurance of the journal's continued life and vigor, is especially gratifying because Mr. von Emperger's labors in establishing "Beton und Eisen" gave the new material, reinforced concrete, its first exclusive representative among technical periodicals. The rapidly increasing employment of reinforced concrete, to which the columns of Engineering News bear faithful witness, justifies Mr. von Emperger's judgment in initiating this departure.


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CHAPTER VI.—The New Sewage Works at Manchester.
CHAPTER VII.—Sedimentation and Single Contact at Oldham.
CHAPTER VIII.—Sedimentation, Septic Tanks and Double Contact Beds at Burnley.
CHAPTER IX.—The Rochdale Pail System and Sanitary Manure Works, Refuse Destructors and Sewage Works.
CHAPTER X.—A Hydrolytic Tank under Construction as a Preliminary to Old Triple Contact Beds at Hampton, Middlesex.
CHAPTER XI.—Chemical Precipitation, Sludge Removal by Siphonage, Contact Beds and Land Treatment at Chadderton.
CHAPTER XII.—Grit Chambers, Contact Beds Followed by Intermittent Filters, with Land for Storm Flow at Aldershot.

PART II.
Works Employing Percolating Filters for Final Treatment.

CHAPTER XIII.—The Change at Birmingham from Chemical Precipitation and Sewage Farming to an Elaborate System of So-called Bacterial Treatment.
CHAPTER XIV.—Chemical Precipitation with Sludge Disposal at Sea, Roughing Filters and Percolating Filters with Spray Nozzle Distributors at Salford.
CHAPTER XV.—Septic Tanks and Percolating Filters with Revolving Sprinklers for Accrington and Church.
CHAPTER XVI.—Chemical Precipitation and Various Experiments, Many on a Large Scale, with Septic Tanks, Continuous Percolating Filters and Other Systems at York.
CHAPTER XVII.—Septic Tanks, Percolating Filters and Rapid Secondary Filters at Salisbury.

PART III.
Sewage Farms.

CHAPTER XVIII.—The Reading, Sandhurst Military Schools and Aldershot Camp Sewage Farms.
CHAPTER XIX.—The Great Sewage Farm of Nottingham.
CHAPTER XX.—The Leicester Sewage Farm and the Proposed Supplementary Works.

PART IV.
Chemical Precipitation Works.

CHAPTER XXI.—Chemical Precipitation and the Proposed Septic Tanks and Contact Beds for London.
CHAPTER XXII.—Chemical Precipitation at Glasgow.
CHAPTER XXIII.—Chemical Precipitation and Divers Experimental Installations at Leeds.

APPENDIX I.
Notes on a Sewage Settling and Screening Plant at Wiesbaden, Settling Tanks at Frankfort-on-Main and the Sewage Farms of Paris.

APPENDIX II.
Definitions or Brief Descriptions of Typical Processes of Sewage Treatment.

This volume is devoted wholly to existing municipal sewage works and is founded on notes made by the author during a tour of inspection ending in June, 1904; the description being afterward revised by the engineers or managers of the various works.

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## Literary Magazines.

"The Panama Canal from a Contractor's Standpoint" is the title of a paper in the January "North American Review," written by Mr. G. W. Crichfield, who thinks "the Culebra Cut is the simplest and easiest problem connected with the canal." He would divide this cut "into 20 sections at the very least, possibly more, and let each section to a responsible contractor on competitive bidding." Then every contractor would be required to establish one overhead cableway for each 100 lineal yards of his section, with the corresponding tools and equipment necessary to keep it occupied, and sufficient labor force to work three 8-hour shifts per day. With this outfit, he thinks that the whole Culebra Cut could be excavated to a depth of 40 ft. below sea-level—for Mr. Crichfield has nothing but scorn for the plans for a canal with locks—within three years from the time of commencing work. Unfortunately, Mr. Crichfield does not tell us how these 20 or more separate contractors would arrange to haul away the spoil from their excavations without interfering with each other. His own figures show some 75,000 cu. yds. of material per day to be disposed of. If all the excavation at Culebra were to be done by hand, Mr. Crichfield's magnificent cableway scheme might possibly be worth attention, but most men experienced in earth handling, we believe, would prefer by far to use steam shovels loading directly into cars for such a job as that at Culebra.

In the same magazine the burning question of the "open shop" vs. "the closed shop" is discussed, with admirable fairness and good temper, by Mr. Henry White, one of the ablest of present-day labor leaders. We can heartily commend Mr. White's article to any who wish to find the point of view of the workingmen who contend for the union shop and all that that implies.

A fine portrait and brief biography of Mr. George Westinghouse is a notable feature of the January "World's Work." Worth mention, also, is an account of how the Wabash Railway obtained an entry into Pittsburg. The writer places the total investment made by the Wabash in bringing about this extension at $35,000,000, which appears to be not at all an extravagant figure to one who understands the magnitude of the tasks which were performed. "The Railroad's Death Roll" is the title of another article in the same magazine, in which current statistics of railway casualties are analyzed and a strong plea is made for the extension of block signals and interlocking plants.

"The Review of Reviews" for January is a Pittsburg number, some 30 pages of its space being taken up with articles descriptive of that truly marvelous city and its wonderfully prosperous enterprises. Among the interesting bits of history recorded in these articles is the fact that the great steel plant at Homestead was originally built by independent manufacturers in 1880-81, as a steel-rail plant with a capacity of about 200 tons per day. A troublesome strike and depression in the steel business brought about the sale of the works to the Carnegie Co. at a very low figure only two years after they were built. The total freight tonnage originating and terminating at Pittsburg in 1903 is estimated at 79,750,000 tons of rail freight and 10,000,000 tons of river freight. It is also recorded here that Mr. Carnegie laid the foundation of his fortune by a lucky speculation in oil with borrowed money.

In the "Nineteenth Century" for December we find an interesting paper on "The Re-flow from Town to Country." The writer sets forth the tendency toward rapid growth of suburbs around all large cities, a tendency to which the development in methods of transit is giving a great stimulus. He sounds a warning, which needs to be heeded as much on this side of the Atlantic as on the other, that, if care is not taken, many suburbs soon become as ugly and monotonous as the city itself. The suburban dweller after his hour's journey homeward reaches not the real country but a narrow house in the street of another city. The writer pleads for greater foresight in the creation of parks and boulevards and the protection of natural scenery as the suburbs increase in population.

## Publications Received.

ANNUAL REPORT UPON THE SURVEY OF THE NORTHERN AND NORTHWESTERN LAKES.—Being Appendix EEE of the Annual Report of the Chief of Engineers for 1904 (W. L. Fisk, Major, Corps of Engineers, U. S. A., in Charge). Washington, D. C.: Pub. Doc. Paper; 6 × 9 ins.; pp. 4,051 to 4,170; folding plates.

A TEXT-BOOK ON ROOFS AND BRIDGES.—Part I.: Stresses in Simple Trusses. By Mansfield Merriman, Professor of Civil Engineering in Lehigh University, and Henry S. Jacoby, Professor of Bridge Engineering in Cornell University. Sixth Edition, Rewritten and Enlarged. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 6 × 9 ins.; pp. 316; two folding and 24 full-page plates and 101 figures in the text. $2.50.

BULLETINS U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 6 × 9 ins.

No. 234: Geographic Tables and Formulas (Second Edition). Compiled by Samuel S. Gannett. Pp. 311; six figures in the text.

No. 236: The Porcupine Placer District, Alaska. By Charles W. Wright. Pp. 35; 10 plates and four maps in the text.

No. 240: Biography and Index of North American Geology, Paleontology, Petrology and Mineralogy for the Year 1903. By Fred. Boughton Weeks. Pp. 243.

No. 245: Results of Primary Triangulation and Primary Traverse, Fiscal Year 1903-04. By Samuel S. Gannett. Pp. 328; one map.

No. 248: A Gazetteer of Indian Territory. By Henry Gannett. Pp. 70.

BUREAU OF THE UNITED STATES CENSUS.—Report of the Director Concerning the Operations of the Bureau for the Year 1903-04. Washington, D. C.: Department of Commerce and Labor. Paper; 6 × 9 ins.; pp. 39.

CANAUX. (A Course in Inland Navigation at the Ecole Nationale des Ponts et Chaussées).—By F. B. De Mas, Inspector-General, Professor at the Ecole Nationale des Ponts et Chaussées. In Encyclopédie des Travaux Publics, begun by Mr. C. Lechalas. Paris: Ch. Béranger. Paper; 6½ × 10 ins.; pp. 579; tables, plates and figures in the text. 17.5 fr. or $5.25.

CHICAGO RAILWAY TERMINALS.—A Suggested Solution for the Chicago Terminal Problem. By Frederic A. Delano (Gen. Mgr., C., B. & Q. R. R., Chicago, Ill.). Chicago: Printed for Private Distribution. Cloth; 9⅝ × 12½ ins; pp. 9; folding and other plates.

WATER SUPPLY OF WASHINGTON, D. C.—By Colonel Alexander M. Miller, Corps of Engineers, U. S. A. Washington Barracks, D. C.: Engineer School. Paper; 6 × 9 ins.; pp. 11; illustrated.

CONNECTICUT STEAM AND STREET RAILROADS.—Fifty-second Annual Report of the Railroad Commissioners, to Which Are Added Statistical Tables Compiled from the Annual Reports of the Steam Railroad Companies of the State for the Year Ending June 30, and of the Street Railway Companies for the Same Period. Hartford, Conn.: Pub. Doc. Cloth; 6 × 9 ins.; pp. 136; large folding map in pocket.

MANUEL PRATIQUE DES MOTEURS A GAZ ET GAZOGENES.—Guide de l'Industriel, de l'Ingénieur et du Constructeur pour le Choix, l'Installation, la Conduite et l'Entretien des Moteurs et Gazogenes. By R. E. Mathot, Ingénieur-Conseil, M. Inst. M. E., M. Soc. Ing. Civils de France. Paris: Ch. Béranger. Cloth; 6½ × 9¾ ins.; pp. 247; tables and 154 figures in the text. 12.50 francs or $3.75.

PROFESSIONAL PAPERS OF THE U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 9 × 12 ins.

No. 30: Forest Conditions in the Little Belt Mountains Forest Reserve, Montana, and the Little Belt Mountains Quadrangle. By John B. Leiberg. Pp. 75; two plates in the text.

No. 31: Preliminary Report on the Geology of the Arbuckle and Wichita Mountains in Indian Territory and Oklahoma. By Joseph A. Taff. With an Appendix on Reported Ore Deposits of the Wichita Mountains, by H. Foster Bain. Pp. 97; eight plates and one map.

No. 33: Forest Conditions in the Lincoln Forest Reserve, New Mexico. By Fred. G. Plummer and M. G. Gowsell. Pp. 47; 12 plates.

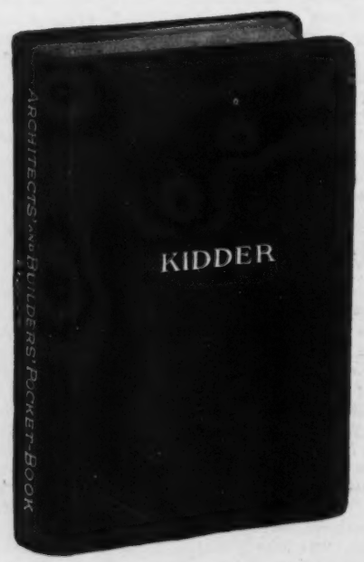
RECHERCHES EXPERIMENTALES SUR LA CONSTITUTION DES MORTIERS HYDRAULIQUES.—By M. H. LeChatelier, Ingénieur en Ches des Mines. Second Edition. Paris: Dunod. Paper; 6½ × 10 ins.; pp. 196.

REPORT OF A RECONNAISSANCE IN TRANS-PECOS TEXAS, NORTH OF THE TEXAS AND PACIFIC RAILWAY.—By George Burr Richardson. The University of Texas Mineral Survey, Bulletin No. 9; Bulletin of the University of Texas No. 23. Austin: The Survey. Paper; 6 × 9 ins.; pp. 119.

STATISTICS OF THE SIX STATES OF AUSTRALIA AND NEW ZEALAND, 1861 TO 1903.—Compiled from Official Sources. By T. A. Coghlan, Statistician of New South Wales. Sydney, New South Wales: Pub. Doc. Paper; 5½ × 8½ ins.; pp. 94. 1s. or 40 cts.

STEAM TURBINES.—References to Books and Magazine Articles in Carnegie Library of Pittsburg, Pa. Paper; 6 × 9 ins.; pp. 23. Send stamp for postage.

STRUCTURAL DESIGNERS' HANDBOOK.—Giving Diagrams and Tables for the Design of Beams, Girders and Columns, with Calculations Based on the New York City Building Code. By William Fry Scott, M. Am. Soc. for Testing Materials. New York: The Engineering News Publishing Co. Cloth; 6 × 9¼ ins.; pp. 158; tables and 74 figures in the text. $2.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